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THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

VOLUME XLVII.—1883.

LONDON:
PUBLISHED AT THE OFFICE, BOY COURT, LUDGATE HILL, E.C.
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THE CHEMICAL NEWS.

VOLUME XLVII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1206.—JANUARY 5, 1883.

ON THE DARK PLANE WHICH IS FORMED OVER A HEATED WIRE IN DUSTY AIR.*

By Lord RAYLEIGH, F.R.S.
Professor of Experimental Physics in the University of Cambridge.

In the course of his examination of atmospheric dust as rendered evident by a convergent beam from the electric arc, Professor Tyndall noticed the formation of streams of dust-free air rising from the summits of moderately heated solid bodies.† "To study this effect a platinum wire was stretched across the beam, the two ends of the wire being connected with the two poles of a galvanic battery. To regulate the strength of the current a rheostat was placed in the circuit. Beginning with a feeble current, the temperature of the wire was gradually augmented; but before it reached the heat of ignition, a flat stream of air rose from it, which, when looked at edgeways, appeared darker and sharper than one of the blackest lines of Fraünhofer in the solar spectrum. Right and left of this dark vertical band the floating matter rose upwards, bounding definitely the non-luminous stream of air." . . .

"When the wire is white hot, it sends up a band of intense darkness. This, I say, is due to the *destruction* of the floating matter. But even when its temperature does not exceed that of boiling water, the wire produces a dark ascending current. This, I say, is due to the *distribution* of the floating matter. Imagine the wire clasped by the mote-filled air. My idea is that it heats the air and lightens it, without in the same degree lightening the floating matter. The tendency, therefore, is to start a current of clean air through the mote-filled air. Figure the motion of the air all round the wire. Looking at its transverse section, we should see the air at the bottom of the wire bending round it right and left in two branch currents, ascending its sides, and turning to fill the partial vacuum created above the wire. Now as each new supply of air, filled with its motes, comes in contact with the hot wire, the clean air, as just stated, is first started through the inert motes. They are dragged after it, but there is a fringe of cleansed air in advance of the motes. The two purified fringes of the two branch currents unite above the wire, and keeping the motes that once belonged to them right and left, they form by their union the dark band observed in the experiment. This process is incessant. Always the moment the mote-filled air touches the wire, the distribution is effected, a permanent dark band being thus produced. Could the air and the particles under the wire pass *through* its mass, we should have a vertical current of particles, but no dark band. For here, though the motes would be left behind at starting, they would hotly follow the ascending current, and thus abolish the darkness."

Professor Frankland,* on the other hand, considers that what is proved by the above described observations is that "a very large proportion of the suspended particles in the London atmosphere consists of water and other volatile liquid or solid matter."

Last summer (1881) I repeated and extended Tyndall's beautiful experiment, not feeling satisfied with the explanation of the dark plane given by the discoverer. Too much stress, it appeared to me, is placed upon the relative lighting of the air by heat. The original density is probably not more than about $\frac{1}{1000}$ part of that of the particles, and it is difficult to see how a slight further lightening could produce so much effect. In other respects, too, the explanation was not clear to me. At the same time I was not prepared to accept Professor Frankland's view that the foreign matter is volatilised.

The atmosphere of smoke was confined within a box (of about the size of a cigar-box), three of the vertical sides of which were composed of plates of glass. A beam of sunlight reflected into the darkened room from a heliostat was rendered convergent by a large lens of somewhat long focus, and made to pass in its concentrated condition through the box. The third glass side allowed the observer to see what was going on inside. It could be removed when desired so as to facilitate the introduction of smoke. The advantages of the box are twofold. With its aid much thicker smoke may be used than would be convenient in an open room, and it is more easy to avoid draughts which interfere greatly with the regularity of the phenomena to be observed. Smouldering brown paper was generally used to produce the smoke, but other substances, such as sulphur and phosphorus, have been tried. The experiment was not commenced until the smoke was completely formed, and had come nearly to rest. In some respects the most striking results were obtained from a copper blade, about ½-inch broad, formed by hammering flat one end of a stout copper rod. The plane of the blade was horizontal, and its length was in the line of sight. The unhammered end of the rod projected from

* A Paper read before the Royal Society Dec. 21, 1882.
† *Proc. Roy. Soc.*, vol. 6, p. 3, 1870.

the box, and could be warmed with a spirit-lamp. The dark plane was well developed. At a moderate distance above the blade it is narrow, sometimes so narrow as almost to render necessary a magnifying glass; but below, where it attaches itself to the blade, it widens out to the full width, as shown in the figure. Whether the heated body be a thin blade or a cylindrical rod, the fluid passes round the obstacle according to the electrical law of flow, the stream-lines in the rear of the obstacle being of the same form as in front of it. This peculiarity of behaviour is due to the origin of the motion being at the obstacle itself, especially at its hinder surface. If a stream be formed by other means, and impinge upon the same obstacles without a difference of temperature, the motion is of a different character altogether, and eddies are formed in the shadow.

The difference of temperature necessary to initiate these motions with this dark plane accompaniment is insignificant. On July 20, 1881, a glass rod, about ¼-inch in diameter, was employed. It was heated in a spirit-lamp, and then inserted in the smoke-box. The dark plane gradually became thinner as the rod cooled, but could be followed with a magnifier for a long time. While it was still quite distinct the experiment was stopped, and on opening the box the glass rod was found to be scarcely warmer than the fingers. It was almost impossible to believe that the smoking matter had been evaporated.

In order to test the matter more closely, smoke was slowly forced through a glass tube heated near the end pretty strongly by a spirit-lamp, and then allowed to emerge into the concentrated sunshine. No distinct attenuation of the smoke could be detected even under this treatment.

It is not necessary to dwell further upon these considerations, as the question may be regarded as settled by a decisive experiment tried a few days later. The glass rod before use was cooled in a mixture of salt and ice, and after wiping was placed in the box. In a short time a dark plane, extending *downwards* from the rod, clearly developed itself and persisted for a long while. This result not merely shows that the dark plane is not due to evaporation, but also excludes any explanation depending upon an augmentation in the difference of densities of fluid and foreign matter.

The experiment was varied by using a U-tube, through which cooled water could be made to flow. When the water was not very cold, the appearances were much the same as with the solid rod; but when, by means of salt and ice, the tube was cooled still further, a curious complication presented itself. Along the borders of the dark plane the smoke appeared considerably brighter than elsewhere. Sometimes when the flow was not very regular it looked at first as if the dark plane had been replaced by a bright one, but on closer examination the dark plane could be detected inside. There seems no doubt but that the effect is caused by condensation of moisture upon the smoke, due to the chilling which the damp air undergoes in passing close to the cold obstacle. Where the fog forms more light is scattered, hence the increased brightness. That the fog should not form within the smoke-free plane itself is what we might expect from the interesting observations of Aitken.

With respect to the cause of the formation of the dark plane, the most natural view would seem to be that the relatively dense particles are thrown outwards by centrifugal force as the mixture flows in curved lines round the obstacle. Even when the fluid is at rest, a gradual subsidence must take place under the action of gravity; but this effect could at first only manifest itself at the top where the upper boundary of the gas prevents the entrance of more dust from above. It is known that air in a closed space will gradually free itself from dust, but the observation of a thin dust-free stratum at the top of the vessel is difficult. If we conceive a vessel full of dusty air to be set into rapid rotation, the dust might be expected to pass outwards in all directions from the axis, along which a dust-free line would form itself. I have tried this experiment, but looking along the axis through the glass top of the vessel I could see no sign of a dark line, so long as the rotation was uniform. When, however, the vessel was stopped, a column of comparatively smoke-free air developed itself along the axis. This I attributed to the formation of an inward flow along the top of the vessel, combined with a downward flow along the axis after the manner described and explained by Professor James Thomson, so that the purified air had been in intimate proximity with the solid cover. It would almost seem as if this kind of contact was sufficient to purify the air without the aid of centrifugal force.

The experiments made hitherto in order to elucidate this portion have given no decisive result. If the thin convex blade already spoken of be held in the smoke-box in a vertical instead of in a horizontal plane, the lines of motion are much less curved, and we might expect to eliminate the influence of centrifugal force. I have not succeeded in this way in getting rid of the dark plane; but since under the magnifier the curvature of the motion was still quite apparent, no absolute conclusion can be drawn.

ON THE NORMAL PARAFFINS.*
(PART IV.)

By C. SCHORLEMMER, F.R.S., and T. E. THORPE, F.R.S.

THIS communication contains the results of an inquiry made to determine the constitution of the heptane which one of them found in the resinous exudation from *Pinus Sabiniana*. The pure heptane was converted into a mixture of chlorides, and these were transformed into the correspoding primary and secondary alcohols. The alcohol was then oxidised, and from the analysis of the silver salts it was proved that *Pinus* heptane had yielded primary heptyl alcohol and methyl-pentyl-carbinol, exactly as in the case of heptane from petroleum.

A second portion of the chlorides was converted into heptylene, boiling at 98·5°, which, unlike the heptylene of analogous constitution, combines only slowly with hydrochloric acid. The heptylene by oxidation was shown to be *butyl-methyl-ethylene*, $C_4H_9CH=CH.CH_3$; it had been formed from the secondary heptyl chloride—

$$C_4H_9—CH_2—CHCl.CH_3.$$

The results of the investigation afford further evidence of the fact that when chlorine acts upon a normal paraffin, not all the chlorides indicated by theory are formed, but only the primary chloride, and a secondaty chloride, which contains the group—$CHCl.CH_3$.

NEW PROCESS FOR THE RAPID VOLUMETRIC DETERMINATION OF BINOXIDE OF MANGANESE.

By J. W. CHALMERS HARVEY.

THE basis of this process consists in heating the sample containing the binoxide with an excess of a solution of stannous chloride and some hydrochloric acid, the following reaction taking place:—

$$1.—MnO_2+SnCl_2+4HCl=SnCl_4+MnCl_2+2H_2O.$$

By now adding ferric chloride in excess, all the excess of stannous is oxidised to stannic chloride, a corresponding amount of ferrous chloride being formed thus:—

$$2.—SnCl_2+Fe_2Cl_6=SnCl_4+2FeCl_2.$$

The iron thus deoxidised is then estimated by a standard solution of potassium bichromate.

* Abstract of a Paper read before the Royal Society, Dec. 21, 1882.

In the first equation one molecule (87 parts) binoxide of manganese connverts one molecule stannous into stannic chloride.

In the second equation one molecule ferric chloride (containing 112 parts iron) oxidises the same quantity of stannous into stannic chloride; therefore 112 parts iron, by their conversion from the ferric to the ferrous condition, correspond in oxidising power to 87 parts binoxide of manganese.

Now if we take two measured quantities of stannous chloride, mix the one directly with excess of ferric chloride, heat gently, and then determine the iron reduced to ferrous chloride, by standard bichromate of potash; then add to the second portion of stannous chloride the binoxide, hydrochloric acid, and heat, then when the binoxide has disappeared, add ferric chloride also in excess, and lastly, determine the iron existing in protoxide; the difference between the iron deoxidised in the former and that deoxidised in the latter case will be due to the conversion of a corresponding amount of stannous into stannic chloride by the binoxide of manganese in the sample.

For example, say the difference, when multiplied up to the percentage = 80 per cent iron, then if—

Iron. MnO_2. Iron.

$$112 : 87 :: 80 = x = 62{\cdot}1 \text{ per cent } MnO_2.$$

Requisites:—Standard Bichromate of Potash.—Dissolve 30 grms. pure bichromate of potash in water and make up to 2 litres; 1 c.c. = 0·017 grm. iron = 0·013205 grm. binoxide of manganese.

Solution of Stannous Chloride.—Dissolve 180 grms. in hydrochloric acid with the aid of heat, and when the solution becomes clear make up with water to 1 litre.

Solution of Ferric Chloride.—Make this by dissolving about 60 grms. iron wire, or (as pure as obtainable) red hematite corresponding to this amount of iron, the former in hydrochloric acid, oxidising with potassic chlorate and boiling off excess of chlorine, the latter in hydrochloric acid, and making the solution up to 1 litre. The solution is conveniently added from a burette.

Conduct of Process.

Weigh out 1 grm. of the finely powdered binoxide, add to it 10 c.c. stannous chloride, about 15 c.c. hydrochloric acid, and heat until all the binoxide is dissolved, now add ferric chloride in excess and again heat for a short time to promote the action of the stannous chloride on the ferric chloride; lastly, estimate the ferrous chloride formed by the bichromate.

10 c.c. of stannous chloride are now heated with excess of ferric chloride and then titrated with bichromate until all the ferrous is converted into ferric chloride. The difference between the number of c.c. used in the latter and in the former case multiplied on the value of each c.c. gives the binoxide in 1 grm. and this by 100 the percentage. It is advisable to estimate the number of c.c. of standard bichromate corresponding to the 10 c.c. (or any other quantity of stannous chloride solution which may be used in the process) before each series of experiments, if any time elapses between them, as the stannous chloride (as is well known) is liable to change.

The whole time required for an assay occupies not more than fifteen minutes.

To test the foregoing process manganous sulphate was dissolved in water, precipitated when boiling with carbonate of soda, the manganous carbonate collected on a filter, dried, and the precipitate then separated from the filter-paper and heated in a muffle for several hours to convert the carbonate into proto-sesquioxide of manganese. This when tested by Fresenius and Will's process gave a result of 36·64 per cent MnO_2 instead of 38 per cent, which, theoretically, it ought to contain—

Fresenius and Will's Process.	Above Process.
36·64 per cent.	36·71 per cent.
—	36·84 ,,
—	36·71 ,,

A sample of commercial binoxide was then tested with the following results.

Fresenius and Will's Process.		Above Process.
56·23 per cent.	1st determination	56·52 per cent.
—	2nd ,,	56·52 ,,
—	3rd ,,	56·64 ,,
	Mean	56·56 ,,

Another sample of commercial binoxide was tested.

Fresenius and Will's Process.		Above Process.
60·50 per cent.	1st determination	60·08 per cent.
—	2nd ,,	60·34 ,,
—	3rd ,,	60·34 ,,
	Mean	60·28 ,,

The process above recommended might also be applied to determine the available chlorine in bleaching-powder.

Instead of proceeding as above the excess of stannous chloride might also be estimated accurately (I should be inclined to think) by a standard solution of ferric chloride.

Experiment in this direction, however, would be necessary to settle this point.

Chemical Laboratory,
Maryport Iron Works,
Dec. 29, 1882.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Bismuth.—Three methods are to be recommended:—

1. The distinctly acid hydrochloric solution is saturated with hydrogen sulphide. All the bismuth is obtained as sulphide, which retains no gallium. The operation succeeds even when the liquid has been rendered turbid by a previous dilution.

2. The bismuth may be reduced by zinc in a solution which is kept distinctly acid, but it is better to use copper which does not introduce impurities like zinc, and the ulterior separation of which from gallium is easy. The acid hydrochloric solution is treated for 12 to 80 hours with an excess of finely divided copper. The liquid is kept at a gentle heat all the time, which hastens the deposition of the bismuth. We find no bismuth in the liquid nor gallium in the deposit (or scarcely a slight trace). The formation of insoluble cuprous chloride is not an inconvenience.

3. In a solution containing one-third of its volume of concentrated hydrochloric acid, and in presence of bismuth, gallium chloride is precipitated by potassium ferrocyanide, either in the cold, or at 60 to 70°. The gallium ferrocyanide, well washed with hydrochloric water, retains no bismuth. It is to be remarked that, contrary to the statements of the chemical text-books, the precipitate formed by ferrocyanide with bismuth chloride is readily soluble in hydrochloric acid, even if dilute.

Boiling potassa does not effect the exact separation of gallium from bismuth. The precipitated oxide is free from gallium, but the alkaline liquid retains a notable quantity of bismuth. It is generally, but erroneously, assumed that in analyses bismuth oxide is completely precipitated by potassa.

Separation from Copper.—According to circumstances we may choose among the four following methods, all of which are good, but the first is to be preferred whenever applicable.

1. The hydrochloric solution, distinctly acid, is treated with a current of hydrogen sulphide. The copper sulphide is then treated with acidulated water containing hydrogen sulphide.

2. On ebullition, kept up for some minutes, potassa

throws down anhydrous cupric oxide containing no gallium. The separation is good.

3. In a solution kept slightly acid zinc easily throws down the copper without carrying the gallium along with it. It is much better to reduce the copper by means of the electrolysis of a sulphuric solution, quite free from chloride. The operation is performed in a platinum vessel, taking the precautions which the author gave for the electrolytic determination of copper. (*Bulletin de la Soc. Chimique*, 1867, first half year, p. 468, and 1869, first half year, p. 35).

4. The separation may be effected by the prolonged boiling of a solution supersaturated with ammonia, provided that the copper is not very abundant, in which case the operation has to be several times repeated. The original hydrochloric solution must be very acid in order that it may afterwards contain a notable quantity of ammonium chloride.

Separation from Mercury.—Of the three following methods the first must be especially recommended as exact and rapid.

1. The hydrochloric solution, distinctly acid, is treated with an excess of hydrogen sulphide.

2. The mercury may be reduced by zinc, or preferably by copper, in a liquid kept slightly acid. The reduction of mercury is more rapid than that of bismuth; it is complete, and the precipitate contains no gallium. The formation of a deposit of cuprous chloride is not an inconvenience.

3. Potassium ferrocyanide may be used for the separation of gallium from mercury in a very acid solution. The precipitate, if carefully washed with hydrochloric water, retains no mercury.

Chemical treatises generally teach that the precipitate formed by potassa in mercuric salts is insoluble in an excess of the reagent. Nevertheless, potassa cannot serve for the separation of gallium from mercury, since the alkaline liquid retains notable quantities of mercury. That part of the mercuric oxide which is precipitated on boiling is free from gallium.—*Comptes Rendus*, Dec. 11, 1882.

ON THE ATOMIC WEIGHT OF YTTRIUM.

By M. P. T. CLEVE.

In 1872 I determined the atomic weight of yttrium by the synthesis of the sulphate from yttria, the purest which I had been able to obtain at that time, by the partial decomposition of the nitrates. At that time we had no knowledge of terbia, an earth without an absorption-spectrum and having a higher molecular weight. As a proof of the purity of the yttrium oxide we depended then on the absence of the absorption-rays, which, since the discovery of terbium, is no longer sufficient. It has therefore been necessary to undertake afresh the determination of the atomic weight of yttrium.

The separation of terbia from yttria is very difficult and requires much time, whilst the yield of pure yttria is very small. The decomposition of the nitrates does not give good results. On the other hand, we cannot avail ourselves of potassium sulphate, or of hydrocyanic acid for the elimination of small quantities of terbia in yttria, though those reagents are useful for the separation of small quantities of yttria in terbia. The only method available is to precipitate an acid solution of the nitrate with oxalic acid, and to determine the atomic weight of the successive fractions.

By this method I finally succeeded in obtaining 3 to 4 grms. of yttria, the molecular weight of which was constant. The percentage proportion of Y_2O_3 in the sulphate was, in four fractions, 48·507, 48·526, 48·497, 48·494. The discrepancies are slight, and fall quite within the limits of experimental error. With this small quantity of yttria I made eight more determinations, in all twelve. I obtained—

Maximum of Y_2O_3 in 100 sulphate ..	48·526
Minimum	48·483
Mean of twelve determinations	48·503
$\pm$0·00029.	

From this mean we may calculate the atomic weight of $Y''' = 89·02$ if $O = 16$ and $S = 32$; or 88·9 if $O = 15·9633$ ($\pm$0·0035) and $S = 31·984$ ($\pm$0·012).

My determinations in 1872 showed 48·605($\pm$0·0096) for 100 Y_2O_3 in the sulphate, and for the atomic weight 89·485.

Pure yttria is perfectly white; the yellow colour which it sometimes has is due to the presence of a trace of terbia. —*Comptes Rendus*, Dec. 11, 1882.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from vol. xlvi., p. 283)

VIII. Boric Acid and Aluminium Plate (*Continued*).

Some able chemists have made extraordinary efforts to reduce borax blowpipe chemistry to a system, but all in vain: they have generally had to assume or suppose that borates of uranium, magnesium, zirconium, and what not, "crystallise out" of the saturated borax bead *per se* on "flaming" or other treatment with the blowpipe; the fact, which can be easily proved, by means of boric acid, being that pyroborates of sodium or potassium can be displaced by no other base whatever, before the blowpipe. If, therefore, they would only be persuaded to bring the noble science of chemistry to bear upon the reactions of indubitable "borates"—such as that formed by the application of pure lime to pure boracic acid B.B.—they would soon make immense strides in the prosecution of pyrology or blowpipe chemistry, in advance of such compilations and imitations from Plattner and Von Kobell as we see produced in the present day. For instance, the application of microscopy and spectroscopy to the "*inner* balls" referred to lately in the CHEMICAL NEWS (vol. xlvi., p. 273) of itself opens up an immense and entirely untrodden field of investigation, obviously suited to advanced microscopical research.

The Analytical Capabilities of Aluminium Plate.

In the Manchester "translation" of the second edition of a German work on blowpipe analysis, the translators say—"the incrustations are thicker on aluminium plate than on charcoal, because the support does not become so strongly heated." This statement seems to me erroneous; and I shall therefore, with your permission, explain what I conceive to be the *rationale* of the action of aluminium plate, in proving my assertion.

The part of a stick of charcoal support where "incrustations" are deposited, is *infinitely cooler* than any part of the aluminium plate, for the simple reason that charcoal is an almost perfect non-conductor, whilst aluminium is the most rapid heat-conductor of any known metal, in consequence of which it is necessary to hold it by means of a pair of muffled forceps. On account of this very rapidity of heat-conduction of aluminium plate, most sublimates deposited upon it can be further treated by the "oxidising and reducing flames" of the blowpipe, affording various characteristic reactions therein, because the heat being so rapidly carried away by this support beneath the coating or sublimate, and thus withdrawn from it, cannot, evidently, be so concentrated on the sublimate itself as in the case of the feebly conducting charcoal; in consequence of which most sublimates are not volatilised again, or re-sublimed by the blowpipe, as nearly all sublimates are when deposited and treated upon a charcoal support.

There is no proof, however, that sublimates are "thicker" upon aluminium than upon cold charcoal; nor indeed, is it easy to perceive in what way such a fact would constitute an advantage. Thus, in Prof. Cornwall's words, the arsenical coating is "very volatile;" the antimonial coating "easily volatile," &c.; when treated by the blowpipe upon charcoal, whilst, in the case of those sublimates deposited together upon aluminium plate, O.P. instantly volatilises the volatile arsenical sublimate, and blackens the fixed antimonial one.

It is not by any means asserted that the above fact constitutes the greatest advantage of using aluminium plate as a support; for instance, the capability of treating a compound of antimony, lead, and copper, such as *Bournonite*, upon the bare plate first, when the antimony is eliminated, then upon a charcoal lozenge, or "slip," as Hutchings called it, when lead can be all sublimed, leaving the copper behind, seems to me a still greater advantage; but I merely venture to offer this explanation, in order to show that the *rationale* of the action of aluminium plate before the blowpipe as given by me in "Pyrology" in 1875, remains unshaken by statements in those text-books which have taken up the subject.

In conclusion, I beg to protest against the modern use of the word "incrustation," applied to these sublimates in some of these text-books. I call rust an incrustation, and suppose in the first place that that phrase implies a modeately hard, not an extremely soft, substance; and secondly, that it has been formed (like rust) from within, and not deposited from without.

THE MANUFACTURE OF POTASH ALUM FROM FELSPAR.*

By HENRY PEMBERTON, Jr.

In the August number of the *Journal of the Franklin Institute* there is an article by John Spiller (first published in the *Journal of the Society of Chemical Industry*, Manchester, April, 1882), in which it is proposed to manufacture potash alum from felspar, by treatment with sulphuric acid and a fluoride, the latter being either fluor-spar or cryolite.

Felspar is a mineral occurring in immense deposits, and containing potash and alumina sufficient to give on a practical scale an amount of alum equal in weight to the quantity of felspar treated. It can be had, under favourable circumstances, at a cost not exceeding a few dollars per ton. The fluor-spar is equally cheap, and the sulphuric acid (as "chamber acid") is manufactured in this country at about 8 dols. a ton. The resulting alum finds a ready market at 40 to 45 dols. per ton, and the margin of profit, therefore, seems to be a very fair one.

I propose to show, however, that the above rosy view is a deceptive one, as far, at least, as the American market is concerned, and that the process is not only a technically difficult one, but will prove to be so expensive that the alum will cost about as much as it will bring.

Taking the typical felspar selected by the author, we have, as its composition—

Silica	65·00
Alumina	17·85
Potash	12·31
Iron, lime, magnesia, soda, &c., by difference ..	4·84
	100·000

To volatilise the 65 per cent silica as tetrafluoride will require 169 parts of fluor-spar, supposing the latter to be chemically pure. We therefore will have the following percentages of bases and acid employed in treating 100 parts of felspar:—

		Per cent SO_3.
17·85 per cent alumina, requiring ..	..	42·00
12·31 ,, potash, ,, ..	..	10·45
169·00 ,, fluor-spar, ,, ..	..	173·33
Total SO_3 required = ..	..	225·78

This is equivalent to 443 parts of "chamber acid" containing 51 per cent anhydride. The acid for the small quantity of other bases present is here neglected.

The author finds it "necessary to get rid of the excess of sulphuric acid by thoroughly heating the decomposed mass in a current of air before dissolving." Any one familiar with the behaviour of alum at a high heat—especially when mixed with three times its weight of sulphate of lime—will fight shy of this operation on the large scale.

Mr. Spiller is perfectly right in asserting that there will be an excess of sulphuric acid in the decomposed mass, even when the quantity theoretically necessary is used. Experience has proved, in decomposing any solid material with acid in this manner, that from 10 to 15 per cent of the material escapes the action of the acid, a corresponding amount of acid also being left uncombined. The reason for this being that the quantity of already decomposed material acts as a dilutent of, and a mechanical separator between, the remaining small quantities of acid and base. The most rational method of obviating this difficulty is to use a proportionally smaller quantity of acid. Charging the above formula, therefore, with only 85 per cent of the acid given, and assuming that the felspar, when mined, hauled, calcined (to render friable), ground and bolted, costs 5 dols. per ton, and the fluor-spar 3 dols. per ton, we have, as the cost of the ingredients—

	Dollars.	
2000 lbs. felspar, at 5 dols.	5·00	
3380 ,, fluor-spar, at 3 dols.	5·07	
7531 ,, 50°B. acid, at 8 dols.	30·12	
		40·19
Labour for mixing, leaching, evaporating, crystallising, and packing, with coal for evaporating, at least		5·00
Eight barrels, at 20 c.		1·60
Yield = 2000 lbs. alum, costing		46·79

Or a little over 2¼ c. per pound, not including general expenses, salaries, insurances, &c. This is just about the present market price for crystal alum.

It will be observed that the weak point in the above process is the quantity of acid required to liberate the fluorine from the fluor-spar, nearly 80 per cent of the acid charged being used for this purpose. About three tons of sulphate of lime, therefore, are formed, from this acid, for every ton of alum made. This bulky, insoluble, useless material, has to be leached to extract the alum, requiring much water, giving weak liquors, and, consequently, wasting much coal in the subsequent concentration.

Recognising these objections, Mr. Spiller proposes cryolite as the source of fluorine, in place of fluor-spar.

This is an idea, if possible, still more unfortunate than the former one. In the first place, cryolite is expensive—exceedingly expensive when compared with the other materials used. In the second place, it yields the wrong alkali—soda, in place of potash. And, thirdly, even if the necessary potash were added (from Stassfurt salts), the resulting Glauber's salt—formed from the soda—would be left as a white elephant upon the hands of the manufacturer; all the whiter from the fact that it is contaminated to the saturation point with potash alum.

It is proposed to pass the fluoride of silicon, evolved from the above decompositions, into water, and to sell the resulting silica and hydro-fluosilicic acid. As the alum industry is one amounting to hundreds of tons, whilst the

* A Paper read before the Chemical Section of the Franklin Institute, Sept. 5, 1882.

most that can be claimed for the silica (for polishing powder) is that it can be disposed of by the hundreds of pounds, the odds against the silica are as 2000 to 1. Still less can be said for the hydro-fluosilicic acid.

So it does not appear that there is much of value in Mr. Spiller's idea. It is true that this article was written for the English market. There the price for materials and labour is unquestionably lower than here. So also is the price the alum will bring. The argument against the process, therefore, will hold good in either longitude.—*Journal of the Franklin Institute.*

ANALYSIS OF HELVITE FROM VIRGINIA.*

By REUBEN HAINES.

The writer was requested by Mr. Henry Carvill Lewis to analyse a mineral he had lately found among others at the mica mines, near Amelia Court House, Virginia, a locality which has become remarkable for its rare minerals. It appears to be Helvite, a rare mineral hitherto found only in Europe; in Saxony, Norway, and Finland. It is a silicate of glucina and manganese, containing ferrous sulphide and manganese sulphide. It occurs in yellow crystals and crystalline masses associated with orthoclase and garnet.

The following mineralogical determinations were made by Mr. Lewis. The crystals were shown by the polariscope to be isometric, but were not sufficiently perfect for angular measurement. Hardness about 6; colour sulphur-yellow; lustre somewhat resinous; partially translucent; fusibility about 4, with intumescence to a brown glass. The mineral gives no water in closed tube; with fluxes reacts for manganese; soluble in hydrochloric acid with evolution of hydrogen sulphide and separation of gelatinous silica.

The specific gravity which I determined myself was 4·306 (see correction in next column.)

The results of my analysis are as follows:—

Siliceous gangue	9·22	32·32 per cent.
SiO_2 (gelatinous)	23·10	
BeO	11·47	
Al_2O_3	2·68	
MnO	45·38	
FeO	1·85	
CaO	0 64	
K_2O	0.39	
Na_2O	0·92	
S	4·50	
Ignition (moisture)	0·30	
	100·45	
Less oxygen replaced by sulphur	2·25	
	98·20	

The total amount of the mineral obtained was scarcely more than one grm. About 0·72 grm. was reserved for general analysis, and the remainder was used for determination of specific gravity, sulphur, and moisture.

The method of analysis pursued was as follows:—

The powdered mineral was dissolved in hydrochloric acid, evaporated to dryness, filtered, and the residue treated on the filter eight times with hot concentrated solution of sodium carbonate, and finally washed thoroughly with hot water. Ignition of the residue gave the siliceous gangue insoluble in acid and in sodium carbonate. There was thought to be less risk in washing on the filter than by boiling up in a beaker and re-filtering. The total silica plus gangue was obtained by weighing the residue of silica from the estimation of sulphur for which about $\frac{1}{10}$ grm. was used. The difference between these two estimations gave the gelatinous silica. The Fe_2O_3 and the Al_2O_3 were separated from MnO and BeO by first repeated precipitation by ammonia, and finally by protracted boiling with concentrated solution of ammonic chloride repeated four or five times to dissolve out all the glucina (Berzelius's method). The Fe_2O_3 and Al_2O_3 were weighed together and titrated by permanganate in the usual way. The glucina and manganese were separated by double precipitation by ammonia, being careful to avoid excess, heating as short a time as possible and filtering soon to avoid re-solution of the glucina. The manganese was precipitated by bromine and then by sodium phosphate, and was weighed as pyrophosphate. The filtrate from the calcium oxalate, after testing for magnesia, was boiled with barium hydrate to obtain the alkalies, which were separated by platinum chloride, and the ignited platinum weighed.

The sulphur was separated and oxidised by dissolving the mineral in hydrochloric acid, to which bromine had been added.

For the specific gravity determination 0·28 grm. was used. It was made in a ten-grm. specific gravity bottle with great care as to temperature and all other necessary precautions.

The moisture was determined in a separate portion, the weight of which was 83 milligrms., by direct absorption in a chloride of calcium tube attached to a combustion furnace.

As regards the silica, it will be noticed that in former analyses the amount given is 33·26 to 35·27 per cent. in two analysis by Gmelin; 33·13 per cent. in one analysis by Rammelsberg, and 30·31 per cent. in one analysis by Teich. If the gangue and gelatinous silica in my analysis are added together we have total silica 32·32 per cent. It appears to me, however, that either we must regard the gelatinous silica alone as a legitimate part of the true species, and consider the "gangue" as accidental impurity, or we must consider the silica of the true mineral as existing in two distinct molecular conditions. The latter hypothesis is scarcely tenable, while the former would require a formula quite different from that given by Dana for Helvite.

* Read before the Chemical Section of the Franklin Institute, May 2, 1882.

Correction to the Above.*

Since the analysis of helvite from Amelia Court House, Va., was published (July, 1882), I have received from Mr. H. C. Lewis another sample of this mineral of much larger amount from the same locality. A re-examination of the specific gravity shows the previous determination to have been erroneous. It is now found to be 3·29. Dana gives the specific gravity as varying from 3·1 to 3·3. The error doubtless originated in attempting to work on too small a quantity of the mineral, less than three-tenths of a grm. having been used. For the determination now given 1·176 grms. were taken, and the same portion afterwards used for general analysis. The material was very carefully picked over several times under a magnifying lens, and only the larger and more uniformly yellow-coloured crystals selected. The largest of these, however, scarcely exceeded from one-twelfth to sixteenth of an inch in diameter. Mingled with the impure mineral sent me was a considerable amount of orthoclase felspar, to which some of the helvite adhered strongly, and also a number of crystals of pale-red topazolite (Lewis), a variety of garnets were observed mixed with the helvite, some adhering to the latter or partially imbedded in it.

A new analysis of the purified helvite gave total SiO_2, 32·49 per cent., of which the insoluble gangue was 5·17 per cent. The latter was determined on about half a grm. of another portion of equally well-picked mineral by boil-

* Read before the Chemical Section of the Franklin Institute, September 5, 1882.

ing the total unignited silica for some time in a concentrated solution of sodium carbonate. In the previous analysis I found total SiO_2 32·32 per cent., and gangue 9·22 per cent. I am inclined to believe that the second determination of the gangue is the more correct of the two, chiefly because larger quantities were used and the treatment with sodic carbonate could be made more thorough. This gangue, obtained as residue insoluble in sodic carbonate solution and afterwards ignited with the filter and weighed, was examined microscopically with the polariscope and an interposed selenite plate. It was found to contain a very considerable proportion of unmistakable free quartz, much of which polarised very distinctly.

The remaining parts of the full analysis of this sample of the mineral have not yet been completed.—*Journal of the Franklin Institute.*

EXAMINATION OF WATER AND AIR FOR SANITARY PURPOSES, WITH REMARKS ON DISINFECTION.*

By ROMYN HITCHCOCK.

It is not my purpose in this note to bring before you any new discovery or observation, but rather to call forth an expression of the opinion of chemists who have been engaged in examinations for sanitary purposes. The question I propound for discussion is this :—

Under what circumstances can a chemist condemn a water for household use?

It is well known that the presence of chlorides, nitrites, &c., in water is indicative of contamination with sewage, or with organic matter of some kind, and, by general consent, such waters are regarded as unsafe for household use. On the other hand, it must be admitted that the constant use of such waters for drinking is only occasionally followed by diseases which can be attributed to them. Certainly chlorides and nitrites are incapable of producing contagious diseases. Therefore, there must be another element in those waters which produce typhoid fever for example, that may or may not accompany the compounds mentioned. At present it is almost universally conceded that this element is a living microscopic germ, which developes and multiplies in the water. If this is true, it is obvious that the results of a chemical analysis are quite incompetent to prove the healthfulness of a water.

Granting this, it may be argued that chemical examinations are quite useless for sanitary purposes. The fact is quite otherwise. For although the chemist cannot detect the germs of disease, which likewise baffle the scrutiny of the microscopist, his analysis indicates the sources of contamination. It enables us, therefore, to trace the contamination to its source and thus determine its nature.

Perhaps it will be a somewhat startling assertion to say that the drainage from vaults containing human dejecta is not necessarily unhealthful. Yet the truth of it is demonstrated by the immunity from contagious diseases of thousands of families whose wells are situated close by and below such vaults. Sanitarians become greatly excited over the condition of affairs in this respect all over the country, and they predict most direful epidemics. But, somehow, the epidemics do not come. Chemists examine the water, Boards of Health order the wells closed, and families complain of the injustice of it because they have never suffered from the use of the water. Evidently, theory and experience do not correspond.

Nevertheless, the explanation is simple enough. Let there be a single case of typhoid fever in a house when the well is thus contaminated, and the probability is that those who drink the water will also take the disease. The germs will be carried into the well. They may be disseminated from it through the entire community, and the result would be, and often has been, a wide-spread epidemic. This is a fact of observation and quite independent of any theory of the origin of disease. Therefore, chemical examinations of water are of value, not in that they prove that the water is unhealthful, but because they indicate the possibility of its becoming a vehicle of disease and point out the source of the contamination.

In regard to the examination of air there is much confusion as to the value of the results. I refer now to air as a vehicle of contagion, and not to its purity from a chemical point of view; and I trust no one will misunderstand my position in this regard, for there is no doubt as to the bad influence upon health of an excess of carbon dioxide, carbonous oxide, and other chemical impurities.

I maintain, however, that air which is chemically pure may be a vehicle of contagion; and that air, which is chemically very impure, may be perfectly harmless as regards contagion. In other words, sewer gas, whatever that strange combination of odours may be, is not, *per se*, a vehicle of contagion. If it were, the population of New York City would be decimated every year. One of the most striking examples of a want of information concerning this subject was given last year by some of the physicians of the highest standing in New York, where the popular excitement about the danger of dirty streets was at its height. The doctors had a great meeting and foretold that there would be a great pestilence if the streets were not cleaned, and they worked themselves up into a state of excitement that frightened the people very much, and, perhaps, at the time they believed all they said. But the city escaped, and the streets were not immaculate, and have not been so since.

I would not say that the health of the city was not affected by the condition of the streets. Very likely it was; but the effect was merely that of air contaminated by the gases arising from the decomposition of refuse matter, and utterly incapable of breeding a pestilence.

Ammonia and sulphuretted hydrogen, and the various other gases which arise in this way do not produce contagious diseases.

But if the atmosphere carries the germs of disease it is not unlikely that these will be most active where the air is impure. For, if these be germs of living organisms they will doubtless find a suitable nidus for growth and multiplication where decomposition is going on, and they will be disseminated by the rising gases. It is very likely that some of them increase in virulence where they grow shielded from the free access of air. But so long as the germs are absent sewer gas or effluvia of any kind will not generate contagia.

About three years ago Professsor R. O. Doremus read an article before the Medico-Legal Society of New York, entitled "Epidemics from a Chemical Standpoint." In the experiment which he then performed the permeability of sandstone, brick, &c., to gases was demonstrated. This fact is well known to chemists, but the experiment proves nothing more than that the poison of contagia may be retained by the porous walls of houses. It should not be inferred, however, that the contagia are able to pass through the stone, for that has not been proved, and is, indeed, highly improbable.

Experiment indicates that all the floating germs of contagious disease may be filtered from the air by means of cotton. Gun-cotton can be employed for this purpose, after which it can be dissolved and the germs will settle to the bottom of the solution where the microscopist can find them. There are also other methods of collecting them for examination. The microscopic examination of air is, therefore, very important. But it should only be entrusted to careful investigators—persons who are not too hasty in drawing inferences from experimental results. The more one studies the microbes of the air the more fully he realises the immense field to be gone over before the results can be properly interpreted. To definitely declare the relation between these microbes and specific

* A Paper read before the American Association for the Advancement of Science, Montreal, August, 1882.

diseases now indicates a very superficial knowledge of the subject. For it is impossible to distinguish by sight between a bacterium that is virulent and one that is harmless.

The results of experience may therefore be summed up in a few words, thus: We have no means of determining when a water which analysis shows is liable to become a carrier of disease does become active in its dissemination, nor can we yet determine whether the air we breathe is or is not loaded with the germs of disease.

But we cannot doubt that after years of continuous observation by competent persons satisfactory results will be obtained. I regard it as a national misfortune that the National Board of Health has been unable to secure an appropriation adequate to continue its work and the publication of the *Bulletin*.

Sceptics may question the value of these investigations, but let us look for a moment at the actual results in saving human life, shown by the statistics of England and Wales for successive periods of ten years since 1841. The annual death-rate for those countries, for ten years, from 1841, was 22·4 in 1000 persons; for the next ten years it was 22·2, and for the next ten years, up to 1870, it was 22·5. For thirty years, therefore, it remained quite stationary. Then sanitary science was applied to diminish the death-rate, and in the next ten years, from 1871 to 1880, it fell to 21·5. This represents the saving of a quarter of a million lives. A further examination of the statistics also shows that this saving of life is in great part due to the effect of sanitary laws upon the prevalence of certain zymotic diseases. In exact figures, 0·78, or more than three-fourths of the improvement, is due to this alone. The fever death-rate has fallen from 0·80 per 1000, in 1870, to 0·32 in 1880.

Another subject, upon which there is considerable misapprehension, is the efficiency of disinfectants. Here again the sanitarian can act without relying upon any theory of disease; for whether there be a living germ or a chemical poison the disinfectant must be strong enough to kill the one, or at least to render it inactive, and to decompose the other. The utter inefficiency of carbolic acid vapour, or of any aërial disinfectant whatever, in a sick-room, will be evident to anyone who is familiar with the microscopic study of living germs. For it is known that they can withstand treatment with chemicals which would instantly destroy the life of higher organisms, and no atmosphere which we could breathe would destroy or materially affect the vitality or activity of disease-germs. It may be said that ordinary aërial disinfection is utterly useless. The only efficient method in the sick-room is the immediate disinfection of all refuse and thorough ventilation.

A more accurate knowledge, on the part of some persons, of the capability of germs to resist destruction would prevent the advocacy of absurd and impracticable schemes for disinfection, such as the freezing out of yellow fever from a ship, and others of like character. It may be assumed with a fair degree of probability, that yellow fever, or any other contagious disease, will not be carried around in a ship's hold if the latter is thoroughly aired and ventilated, and by a proper regard to sanitary conditions the quarantining and disinfection of vessels, after long voyages from infected ports, would be rendered quite unnecessary.—*Journal of the Franklin Institute.*

A New Variety of Glass.—The *Wiener Gewerbe-Zeitung* states that a chemist of Vienna has invented a new kind of glass, which contains no silex, potash, soda, lime, nor borax. In appearance it is equal to the common crystal, but more brilliant; it is perfectly transparent, white, and clear, and can be cut and polished. It is completely insoluble in water and is not attacked by fluoric acid, but it can be corroded by hydrochloric and nitric acid. When in a state of fusion it adheres to iron, bronze, and zinc.—*Gaceta Industrial.*

CORRESPONDENCE.

THE PROPOSED MEETING OF THE BRITISH ASSOCIATION IN CANADA.

To the Editor of the Chemical News.

Sir,—I received a circular from members of the British Association who are opposed to meeting in Canada. Some of their arguments are good, but none are to me overpowering. It is said that the founders never contemplated going out of Britain. The founders of the kingdom of England never contemplated growing into Britain, or Great Britain, and Greater Britain. This latter fine expression seems to have escaped the sympathy of many scientific men. For one I should feel glad to see Canada included in our scientific limits, and I think that the Association might do much towards promoting fellow-thought in Science, as well as fellow-feeling, or feeling of kinship.

It is said that the present practice has been justified by fifty years, and the change will be disappointing. Fifty years, and no change! Is not this disappointing? The British Association is perhaps the least disposed of all the great societies to yield to a clique; but is it not possible that, even to this scientific body, the breezes of the Atlantic might impart vigour, blow out the dust from many a corner, and help the cure of troublesome sores, if any exist?

Is not the desire itself to go to Canada a proof of the fine influence of the Associaton? Its spirit is spreading abroad. Are we so old or so narrow that we can only stay at home?

Many societies are imitating the Association in their annual meetings, and the great interest in the larger one has visibly diminished, and must diminish more unless there is some change. Financial difficulties may occur, but I should be sorry to see the Association straining itself to make attractions on this account. I should prefer to see it pressed for time to deliver its message to the public, and this might happen if its meetings were rarer here, as we cannot expect that all who would read papers at home would go to Canada. This would leave more for the next meeting here. Canada would not see the meeting in all its vigour, but both sides would make friends, and both would work more freshly in their homes after their discussions.

A decision could not be arrived at unless a number of the members here would go to represent in a fit manner the Association. I hope this number will be found, and I am only sorry that I cannot be one.—I am, &c.,

R. Angus Smith.

Manchester, December 29, 1882.

NITROGEN IN COAL.

To the Editor of the Chemical News.

Sir,—At a meeting of the Chemical Society on the 21st ult. a paper was read by Professor Foster on the "Behaviour of Nitrogen in Coal during Destructive Distillation." This subject was taken up by Mr. William Young and the writer several years ago, with the result that a process was devised and patented by which a very large proportion of the nitrogen which had formerly been left in the coke or carbonaceous residue from the destructive distillation of coals, shales, ironstones, &c., can be recovered commercially. This process has been in successful use on a large scale since May, 1881. I have no wish to use this as an opportunity for the advertisement of a patented invention, and therefore refrain from saying anything as to the process and its results. The Patents referred to are 1587, 2169, 4284, all of 1881, and 1377 and 5084 of 1882.

A few months ago I consulted Professor Crum Brown

as to the propriety of bringing a paper on the subject before the Chemical Society, but we agreed in thinking that from a purely scientific point of view the facts brought to light were either not sufficiently novel, or where novel, were not sufficiently clearly worked out on the scientific side, to justify me in bringing them before a scientific society. My partner, Mr. Wm. Young, read a technical paper on the subject before the North British Association of Gas Managers several months ago. I fully appreciate the scientific value of Professor Foster's papers, and regret not having been present at the meeting to hear it. —I am, &c.,

George Beilby.

Midcalder, January 2, 1382.

ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE.

To the Editor of the Chemical News.

Sir,—For some months past I have been closely engaged in testing the accuracy, under various conditions, of the above method for estimating phosphoric acid, and I fear it will be some months before the enquiry can be brought to a close.

In the Chemical News (vol. xlvi., page 213) I observe an article from the *Journal of the American Chemical Society* on the same subject by Mr. Gladding, who has worked with microcosmic salt, the substance which I also have employed.

In his experiments no allowance appears to have been made for the solvent action of the dilute ammonia used to wash with. Though the loss sustained from this cause appears to me at present to be less than has generally been supposed, it is undoubtedly a measurable quantity, introducing an error, which, though it may be compensated and in many instances more than balanced, by error in the other direction arising from retained impurities, must not be lost sight of, as it will sensibly affect the results if we succeed in obtaining a pure precipitate.

My paper when complete will be offered as a contribution to your valuable journal.—I am, &c.,

David Lindo.

Falmouth, Jamaica,
December 7, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 25, December 18, 1882.

On Maize at Different Epochs of its Vegetation.—M. H. Leplay.—The author demonstrates the conversion of sugar into cellulose, and has succeeded in the artificial reproduction of this phenomenon.

On Solar Photometry.—M. A. Crova.—The author proposes to obtain the measure of the relative intensities of two lights of different tints by the photometric comparison of one and the same simple radiation chosen in each. In the sun and in the standard Carcel lamp he selects a yellowish green radiation of the wave-length 582. Practically it is obtained by means of a mixture of solutions of ferric and of nickel chlorides, through which the light is allowed to pass. Daylight and lamplight seen through this medium appear exactly of the same colour. By making use of this method he finds the light of the sun in a clear sky equal to 60,000 Carcels.

Researches on the Duration of the Solidification of Bodies in a State of Superfusion.—M. D. Gernez.—The author has made some determinations on phosphorus in a state of superfusion in very narrow glass tubes. He finds that in the same tube the duration of the solidification is the same for equal lengths of the liquid column. The temperature to which the phosphorus had been previously heated had no influence. The rate of solidification remains constant however many anterior operations have been effected with the same body, and what may have been the duration of each.

Crystallisation of Chlorine Hydrate.—M. A. Ditte.—The author describes a process for obtaining this compound in well-defined crystals, of 2 to 3 m.m. in length. Their colour is of a deep greenish yellow, and their form is derived from the regular system.

On Pyro-sulphuryl Chloride.—M. D. Konovaloff.—M. Ogier has recently drawn attention to this compound as forming an exception to the law of Avogadro. M. Konovaloff shows that this is not the case, its vapour-density being normal. The following determinations have been obtained experimentally:—7·37, 7·20, 7·24, 7·41, 7·23, 7·39. Theory requires 7·43.

The Products of the Distillation of Resin.—M. Ad. Renard.—The portions of the volatile oil which passes over below 100°, if washed with soda and agitated with a strong solution of sodium bisulphite give a crystalline deposit, formed by a combination of sodium bisulphite with various aldehyds. The portion which resists solidification is washed afresh with soda and by fractionated distillation is split up into two hydrocarbons, boiling, the one at 67°—70°, and the other at 30°—40°.

Justus Liebig's Annalen der Chemie,
Band 215, Heft 3.

On Caffeine, Theobromine, Xanthine, and Guanine.—Emil Fischer.—The author undertakes in this memoir a revision of Rochleder's experiments on the decomposition of caffeine by chlorine. Like Rochleder he obtains amalic acid, chlorocyan, and methylamin, but considers them as products of a secondary reaction. He then describes the derivatives of caffeine, *i.e.*, chloro-caffeine, bromo-caffeine, amido-caffeine, ethy-oxy-caffeine, hydroxy-caffeine, di-ethoxy-hydroxy-caffeine, di-meth-oxy-hydroxy-caffeine, allo-caffeine, apo-caffeine, caffuric acid, hydro-caffuric acid, hypo-caffeine, caffeline, with its reduction and oxidation products, the latter of which vary according as the agent employed is potassium ferricyanide, permanganate, or chromic acid; further, acetyl-ace-caffine, and ace-caffine. Under theobromine he describes bromo-theobromine, brom-ethyl-theo bromine, hydroxyl-ethyl-theobromine, and hypo-ethyl-theobromine. He remarks that one and the same methylamine is split off in the formation of the apo- and hypo-compound both of caffeine and theobromine. He then describes the preparation of xanthine and its conversion into theobromine and secondarily into caffeine. Thus it is proved that theobromine and caffeine are respectively to be considered as dimethyl- and trimethyl-xanthine, and suggests that, as the vegetable bases theobromine and caffeine are so closely related to the animal excretions xanthine and guanine, all these compounds are possibly formed in the organism by the same process.

Communications from the Chemical Institute of the University of Strasburg.—These consist of a paper by R. Henriques on new nitro-compounds of phenol; a memoir by Paul Hepp on the trinitro-derivatives of benzol and toluol; and a paper by the same author on the addition-products of nitro-derivatives with hydrocarbons.

Cosmos Les Mondes.
No. 15, December 9, 1882.

This number contains no chemical matter.

No. 16, December 16, 1882.

A man who was very close to a tree struck by lightning asserts that he was saved by crouching on the ground and covering himself with a *woollen* umbrella. He was "enfolded in flames and completely electrified," but received no hurt!

No. 17, December 23, 1882.

M. Maumené addresses to the editors a letter which he had previously forwarded to the *Annales de Chimie et de Physique*. In this letter he points out that he has been the first, as admitted by MM. Dumas, Pasteur, Chevreul, aud Würtz, to advise chemists not to study chemical actions without determining all the terms. He adds that his theory has enabled him to foresee the existence of eight acids, two of which he has produced and analysed, whilst the remainder will be obtained shortly.

Falsification of Oils.—M. Barthe.—The author gives a table of the specific gravities of the chief vegetable oils, and of their mixtures.

Mixed Domestic Lighting.—An illustrated paper.

Journal de Pharmacie et de Chimie.
Tome vi., November, 1882.

Researches on Jalaps.—M. A. Bouriez.—A purely pharmaceutical paper.

Assays of Potassium Sulpho-Carbonates. — M. Guyot-Dannecy.—The author, to determine the proportion of carbon disulphide present, introduces into a 2-litre flask 1 litre of distilled water, in which 100 grms. zinc chloride are dissolved. In this flask is adapted a good cork with two holes. Through one of these is plunged a long tube-funnel, the lower end of which reaches to 1 centimetre from the bottom. To the second hole is fixed a tube bent at right angles, for conducting the vapours into a condenser cooled by a current of cold water, and thence into a receiver plunged in ice. The apparatus being thus arranged and the joints made air-tight, the flask is placed in the water-bath and heated. When the solution of zinc chloride has reached about 60° the potassium sulpho-carbonate is introduced little by little through the tube-funnel. There is produced a brisk effervescence due to the escape of carbon disulphide. No more sulpho-carbonate must be added until this has entirely ceased. The process is thus continued till the whole of the weighed sample has been introduced, when the distillation is continued until all the carbon disulphide is collected in the receiver. Its weight indicates its proportion in the sulpho-carbonate.

Analysis of Ground Alunite as Supplied to Alum Works —The alunite in question is that of La Talfa, near Rome. It contains potassium sulphate 13·20 per cent; aluminium sulphate combined with potassium sulphate 25·52; free sulphate of alumina, 4·60; and free alumina, 17.

On a Variety of Albumen in Urine Coagulable by Nitric Acid and Re-soluble in Alcohol.—M.L. Garnier. —In two cases of nephritis the urine on treatment by Heller's process gave a precipitate which instantly re-dissolved in alcohol.

New Method of Preparing Vesicatories. — M. Limousin.—A memoir of purely pharmaceutical interest.

Extract of a Medico-Legal Report on a Case of Poisoning by Strychnine.—MM. Schlagdenhauffen and Garnier.—The authors describe very circumstantially their examination of the stomach, brain, and liver of Ernestine Martiné. They ascertained the absence of brucine and morphine, and proved the presence of strychnine by its physical and chemical characters, and by its physiological effects upon a frog and a rabbit. Arsenic was also found in the stomach, liver, and brain.

The Electrical Exhibition.—M. Le Roux.—The continuation of a lengthy illustrated memoir.

Preservation of Woods.—M. Fayol.—The author finds that treatment with tar increases and sometimes doubles the duration of oak timber used in collieries, but has little influence upon that of pine. Oak wood prepared with ferrous sulphate lasts ten times longer than in its unprepared state, on immersion for 24 hours in a solution of 200 grms. ferrous sulphate per litre.

Rapid Preparation of Oxygen.—M. Voracek.—The author pours hydrogen peroxide upon a small quantity of potassium permanganate. There is an abundant disengagement of oxygen at common temperatures.

New Reagent for Nitrous Acid.—M. Jorissen.—From the *Zeitschrift f. Anal. Chemie.*

Preparation of Succinic Acid from Tartaric Acid. —M. F. König.—Dissolve 2 kilos. tartaric acid in water, neutralise with ammonia, dilute to 30 litres, add to the solution 20 grms. potassium phosphate, 10 grms. magnesium sulphate, a few grms. calcium chloride, and about 20 c.c. of a solution of ammonium tartrate in fermentation which is easily obtained by letting some of the same liquid stand for some days, diluted with five times its weight of water. By degrees the mixture becomes turbid, and swarms with bacteria. It is then left to itself for six to eight weeks at a temperature of 25 to 30°, covered as well as possible from the air, until the slight escape of gas ceases, and there is no more tartaric acid. It is then evaporated to expel ammonium carbonate, clarified with white of egg and milk of lime so as to leave the boiling liquid alkaline. When cold the deposit of calcium succinate is pressed and decomposed by sulphuric acid. The liberated succinic acid is purified by known means. Two kilos. tartaric acid yield 500 grms. succinic acid, the theoretical yield being 524 grms.

Composition of Human Fat at Different Ages.—M. L. Langer.—The fat of a child contains less oleïc acid, but more palmitic and stearic acid than that of adults. It is also richer in the butyric and caproic acids.

Molybdenum Binoxide.—F. Mauro and R. Panebianco.—This compound may be obtained in definite crystals by heating in a platinum crucible at the high temperature of a Perrot furnace for three or four hours a mixture of 14·4 grms. anhydrous molybdic acid, 14 grms. dry potassium carbonate, and 7 grms. of melted boric acid. It is let cool in the furnace. On treating the fused mass with water the enclosed crystals are liberated, and are washed first with ammonia and then with water. The crystals are prisms with a four-sided base terminating in a pyramid. They have a metallic lustre, a colour between that of copper and of lead, and their sp. grav. at 16° = 6·44. Crystalline molybdenum binoxide may be transformed into molybdic acid; the conditions of this conversion lead the authors to take 96 as the atomic weight of molybdenum, thus agreeing with the determinations of M. Dumas and M. Debray.

December, 1882.

On the Origin of Arsenic and Lithia in Selenitic Waters. — M. Schlagdenhauffen. — The author finds arsenic in all varieties of gypsum which he has examined. He considers that the subterranean waters take up calcium arseniate from the gypsum beds. The origin of the arsenic contained in the gypsum is doubtless the arsenic sulphide contained in marls along the pyrites. This arsenic sulphide in contact with waters charged with calcium carbonate and bicarbonate is gradually converted into calcium sulph-arseniate and finally arseniate, in which state it dissolves in the water. The marls contain also lithia, though in a form yet unknown.

Rapid Process for Determining Salicylic Acid in Beverages.—M. A. Rémont.—A colorimetric process already noticed.

Want of Permanence in Syrup of Tolu.—M. Malenfant.—A purely pharmaceutical paper.

Analysis of the Coal of Muaraze.—M. A. Guyot.—This coal, from the valley of the Zambesi, is found in thin beds intersected by carbonaceous schists. It contains from 22 to 29 per cent of ash.

Presence of Arsenic in the Waters of Baréges.—M. Schlagdenhauffen.—The waters in question contain arsenic in the form of alkaline arseniate and sulph-arseniate.

Cultivation of Opium in the Zambesi.—M. P. Guyot.—Not suitable for our columns.

Artificial Colouration of a Cinchona by Ammonia.—MM. Ch. Thomas and G. Guignard.—It is common to transform common yellow barks into red barks by steeping them for a few moments in ammoniacal water. To detect this fraud the authors treat a standard bark and the suspected sample with boiling water under identical conditions. The liquids obtained are filtered, and when cold are tested with Nessler's reagent, freshly prepared. The standard sample gives a white precipitate, but the artificially coloured sample gives a very decided red-brown colouration.

Modifications Produced in Milk by Certain Medicines.—Dr. Stumpf.—Potassium iodide diminishes notably the secretion. The albumenoid matter suspended in the milk and the sugar increase, whilst the fatty matters diminish. The quantity of the potassium iodide eliminated in the milk is very slight. The use of alcohol increases the fatty matter but leaves the albumenoid principles and the lactose, as well as the total quantity of the milk, unaltered. Salicylic acid stimulates the secretion, but pilocarpine has no such action. Salicylic acid increases the proportion of lactose. In women this substance passes into the milk in larger proportion than in the female herbivora. The use of plumbic preparations causes lead to appear in the milk.

Toxicological Detection of Solanine.—M. Dragendorff. – Not capable of useful abstraction.

Reaction of Narceine.—M. Arnold.—If we heat a trace of narceine with a mixture of equal parts of sulphuric acid and of phenol we obtain at first a yellow colouration, then a brown, and when the phenol begins to volatilise a fine cherry-red colour, if the action of the heat is continued. Some drops of water suffice to transform this colour into a dirty yellowish white. Veratrine, if similarly treated, gives the same red colouration, but on the addition of water it gives a canary yellow. Codeine becomes a dirty violet-red, and of a dirty brown if the temperature is raised. Delphinine is at first a brick-red, which turns to a reddish-brown on heating.

Creosote of Beech-Wood Tar.—M. Gratzel.—Creosote with an aqueous solution of ferric chloride takes a blue colour which quickly passes to a brown. Phenol, if similarly treated, takes a violet-blue colour, which is permanent.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xi., Part 10.

Quantity and Composition of the Rain and Drainage Waters at Rothamsted.—Messrs. Lawes, Gilbert, and Warington.—From the *Journal of the Royal Agricultural Society.*

Formation of Nitric Acid in the Soil.—From the *Journal of the Society of Arts.*

Formation of Nitric Acid in the Soil.—Marié-Davy.—Soil from the plain of Gennevilliers was placed in a glass vessel and received daily 1 litre sewage which contained initially 20·6 m.g. ammoniacal nitrogen and 0·8 m.g. nitric nitrogen per litre. In the effluent there was, per litre, 1·7 m.g. ammoniacal nitrogen and 21·5 nitric nitrogen.

Influence of the Texture of Commercial Manures upon their Efficiency.—Prof. P. Wagner.—In every case finely-ground manures gave the best results.

Interchange of Gases and the Chemical Modifications in a Hen's Egg during Incubation.—R. Pott and W. Preyer.—Not suitable for abstraction.

Food Experiments with "Huck's Strength Food" on Horses.—Vet. Surgeon Pindeisen.—The horses experimented upon gained very decidedly in weight.

Micro-spectroscopic Observation of the Excretion of Oxygen from Vegetable Cells.—Th. W. Engelmann.—The separation of oxygen from the green cells depends on the wave-lengths of the light. The greatest liberation of oxygen was occasioned by the rays between Frauenhofer's lines B and C.

Excretion of Carbonic Acid from Plants in the Absence of Oxygen.—W. P. Wilson.—The author refutes Wortmann's view that the carbonic acid exhaled by plants is entirely a product of intra-molecular processes.

Action of Various Gases and Especially of Nitrous Oxide.—Seeds of the pea and of wheat cannot germinate in an atmosphere of pure nitrous oxide, and a prolonged stay in this gas proves fatal. Living plant-cells are incapable of decomposing pure nitrous oxide and of utilising its oxygen.

Action of Gases and Liquids upon the Vitality of Vegetable Forms.—Italo Giglioli.—Air-dried seeds resisted the action of nitric oxide, hydrogen sulphide, and sulphurous acid, and even of dry ammonia, for some time. Moist seeds perished quickly in the above gases, and even in oxygen and nitrous oxide. Seeds of lucerne in some cases resisted the action of boiling ether (160 hours), boiling carbon disulphide (81 hours), and boiling absolute alcohol (5 hours).

Cholesterines.—E. Schulze and J. Barbieri.—From the *Journal fur. Praktische Chemie.*

Contributions to a Knowledge of Lignine and of Lignified Tissues.—Max Singer.—Not suitable for abstraction.

Determination of the Mineral Constituents of a Sugar-Cane Affected by Fungoid Disease.—Prof. W. Knop.—The most remarkable point is the great quantity of magnesia in proportion to the lime. The large quantity of chlorine and the low percentage of the total ash are also noteworthy.

Enemies to the Vine.—F. V. Thürmen, Madame Ponsot, &c.—A description of fungi, insects, &c., injurious to vineyards.

Journal für Praktische Chemie.
New Series. Vol. xxvi, Nos. 6 and 7. 1882, 17 and 18.

Platinum-Bases Formed by the Electrolysis of Ammonium Carbaminate and Carbonate with Alternating Currents and Platinum Electrodes.—Bruno Gerdes.—The author obtains two new bases, ammon-platin-diammonium and diplatin mono-diammonium.

Ammon-platin-diammonium Compounds.—E. Drechsel.—Remarks on the foregoing manual.

On Carbon Disulphide, and Especially on its Behaviour with Potassium Permanganate.—Eugen Obach.—The author's principal results are that neither solid potassium permanganate nor its aqueous solution, neutral or acidified, has any direct action upon pure carbon disulphide, nor upon the evil-smelling impurities present in commercial samples. Hydrogen sulphide, if present, is destroyed, and free sulphur often passes into solution. The slow reduction of the permanganate solution effected by pure carbon disulphide is a secondary reaction depending upon hydrogen sulphide, which is formed by the action of light. In impure carbon disulphide the amount of the fixed matter which remains after evaporation is increased by prolonged treatment with permanganate. Among the substances tried as purifying agents powdered mercury sulphate gave the best results as far as the removal of the thio-carbimides is concerned. For complete

purification, after the previous removal of water and dirt, the following method is recommended :—Distillation over quicklime, agitation with powdered permanganate, then with metallic mercury, and afterwards with mercury sulphate. Lastly, rectification over calcium chloride directly into the stone bottle, which must be preserved from light. Silver, mercury, and copper act upon carbon disulphide, which is otherwise pure but contains hydrogen sulphide, rather quickly in presence of air, with formation of the corresponding sulphides. If air is excluded silver is not at all discoloured, mercury scarce perceptibly, but copper distinctly. When testing for traces of free sulphur in presence of hydrogen sulphide the operation must be conducted in a filled test-flask, so as to exclude air. Alkaline solutions of lead decompose sooner or later the vapour of carbon disulphides and certain of the thio-carbimides, so that they cannot be used for the detection of hydrogen sulphide.

Foundation of my Estimates of Ad. Baeyer's Scientific Qualification.—H. Kolbe.—A personal criticism not suitable for reproduction in the Chemical News. The author concludes with the remark that chemical science in Germany declines more and more.

Elementary Composition of Rice-Starch, and on its Quantitative Determination.—F. Salomon.—Not adapted for useful abridgment.

Uro-roseine, a New Urine Pigment.—M. Nencki and N. Sieber.—This pigment was first found on adding pure hydrochloric acid to the urine of a diabetic patient. In four other cases of the same disease it was absent. Hitherto it has not been detected in the urine of healthy persons, but in that of about 10 per cent of patients affected with chlorosis, osteomalacia, nephritis, typhus abdominalis, &c. It is of a beautiful rose-colour, dyes wool and silk, and may be separated from urine by gentle agitation with amylic alcohol. It is very unstable, and has not yet been sufficiently purified for analysis.

Revue des Industries et des Sciences Chimiques et Agricoles.
Tome vi., No. 58.

Meeting of the Central Society of Chemical and Agricultural Sciences and Industries, April 27.—M. Joulie, with reference to a lecture which he had lately delivered on wheat, remarked that in analyses of soils, he attended only to the potassa soluble on digestion of the soil in *aqua regia*. The potassa present in the form of silicates not attacked by this solvent must be ignored, as it was not available as plant food. The solvent power of *aqua regia* for potassium compounds far exceeds the absorptive power of plants, so that only a small fraction of the potassa thus dissolved can be considered available. Except in calcareous districts, the greater part of arable soils contain no phosphate but that of iron. The phosphates introduced as manure, whether alkaline or alkine-earthy, are rapidly converted into iron phosphate on being dissolved in the carbonic acid, which impregnates the soil. A soil in order to yield 40 kilos. of phosphoric acid to a crop of wheat, must contain at least 4000 kilos. of that acid in the arable stratum. Organic matter is useful by reducing ferric phosphate to the ferrous state. The latter salt yields its acid more easily to plants.

Note on the Phosphates of Brazil.—M. Pellet.—These phosphates much resemble those of Burgundy, and contain much alumina and iron.

Studies on Means of Reducing the Production-Cost of Wheat.—H. Joulie.—Not capable of useful abridgment.

Treatment of Waste-waters.—MM. Gaillet and Huet.—There is here little novelty. Ferric chloride is recommended as a precipitating agent, and, in general, sulphates are pronounced inferior to chlorides. The precipitated matter is recommended as a source of lighting-gas. A strange process is described, in which the sewage, &c., is treated first with lime, then with oxalic acid (*sic !*), and lastly with oxalic acid again.

Tome vi., No. 59.

Note on the Volumetric Determination of Carbonic Acid.—Armand le Docte.—The author proposes a new apparatus, the construction and use of which cannot be intelligibly described without the accompanying diagram and tables.

Means of Reducing the Production-Cost of Wheat (Continuation).—The author shows that farmyard manure does not offer its elements in forms sufficiently available, and that its use in large doses involves a heavy outlay; the only result is to enrich the soil uselessly with elements of little activity. The author sums up his advice for the production of wheat cheaply as follows :—Keep the soil always well stored with the indispensable mineral elements, which will not cost more than 1·09 franc per hectolitre of wheat. Take possession of the nitrogen of the atmosphere by the cultivation of forage plants, which then transfer it to the wheat. M. Joulie, like M. Ville, considers that lucerne, &c., assimilate the free nitrogen of the atmosphere.

Tome vi., No. 60.

Culture of the Sugar-Cane at Guadeloupe.—The author recommends to apply 80 to 100 grms. of chemical manure per plant, covering it with a layer of soil. The number of canes per hectare is 10,000.

Nutritive Value of the Different Pulps from Sugar Works and Distilleries.—H. Pellet.—Not capable of useful abstraction.

Studies on the Vanadium Industry.—F. Osmond and G. Witz.—Already noticed.

Tome vi. No. 61.

Studies on the Vanadium Industry.—F. Osmond and G. Witz.—Continued from the last number.—The authors give the following methods for the rapid determination of vanadium.

A. *Lindemann's Method.*—If, to a sulphuric solution of vanadic acid, we add a standard solution of ferrous sulphate, the iron passes to the maximum state of oxidation, and the vanadic acid is reduced to the hypo-vanadic. The liquid, which is at first of a light yellow, turns to a green and then to a blue. The reaction is complete when a drop, placed upon a white porcelain plate, turns a drop of freshly made and very dilute solution of potassium ferricyanide to a blue. It is necessary to operate in presence of a notable excess of sulphuric acid, otherwise the reaction remains incomplete. This method is applicable in presence of all the components of basic slags. We prepare beforehand:—(1.) Dilute sulphuric acid formed of 1 vol. mono-hydrated acid and 4 vols. water. (2.) A solution of ferrous sulphate obtained by dissolving, with exclusion of air, 2·183 grms. pianoforte wire in the acid above mentioned, and diluting it to 1 litre with the same. 1 c.c. corresponds to 2 m.g. vanadium. It is well to prepare this solution afresh for each series of determinations. (3.) A weak solution of potassium permanganate equivalent to the former, and containing 1·234 grm. pure permanganate per litre. (4.) A stronger solution of permanganate, *e.g.*, such as is used in the determination of iron in minerals. We treat 2 grms. of powdered slag with 30 c.c. of the sulphuric acid (1.); the action is almost instantaneous. We boil for a few moments and let cool. The presence of silica and calcium sulphate do not prevent the determination, but they interfere a little with the distinctness of the reactions. It is therefore preferable to attack 6 grms. slag with 90 c.c. of acid and filter off the third of the volume, or 30 c.c., which represent 2 grms. The vanadium and the iron are found dissolved in an undetermined state of oxidation. Both are brought to the maximum state by the stronger solution

of permanganate, added drop by drop until a permanent rose colour is produced. If an excess of permanganate has been employed it is destroyed by means of ferrous sulphate. The ferrous solution is then run in with the burette. When the colour begins to take a blue, like the copper salts, we learn that the point of saturation is near. The sulphate is then added more slowly, and spotting trials are made until a drop of the liquid gives a distinct blue colour with the dilute ferricyanide.

B. *Colorimetric Method.*—Hypo-vanadic solutions may be very rapidly determined by comparing them either with a standard of known strength or with a salt of copper. The limit of exactness which the authors have reached in this manner appears to be 1-50.

C. *Spectro-photometric Observations.*—The choice of cupric solutions as permanent standards for the determination of vanadium is justified not merely by an apparent identity, but by the inner nature of the two colourations. We have compared with the fine spectro-photometer of Crova a solution containing per c.c. 2 m.g. of vanadium in the state of Va_2O_4 and a solution of cupric nitrate of an equivalent coloration. Both present the same general characters; absorption of the red part of the spectrum decreasing to beyond the ray D. Hypo-vanadic solutions rendered green by an excess of hydrochloric acid give an absorption spectrum differing little from that of the blue solutions.

On the Incrustations of the Triple Effects.—H. Pellet.—For the prevention of these incrustations the author recommends the filtration of the cane-juice, the use of lime free from sulphate, and the precipitation of dissolved sulphate by means of ammonium carbonate.

Use of Manures in Vineyards.—Dr. A. Stutzer.—Each vine should receive yearly 6 to 7 grms. soluble phosphoric acid, 5 to 6 grms. potassa, and 2½ to 3 grms. nitrogen.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 2, 1882.

Process for Determining Ammonia by Distillation.—Dr. O. Knoblauch.—This memoir cannot be usefully reproduced without the accompanying illustration.

Preparation of Normal Acid.—Dr. O. Knoblauch.—This paper cannot be understood without reference to the foregoing.

Expansion of the most Important Volumetric Solutions by Heat.—A. Schulze.—The author refers to a memoir by P. Casamajor, in which the latter maintains that the expansion of volumetric solutions by heat cannot be neglected in case of exact determinations, but that the tables of expansion calculated for pure water may be safely applied in view of the great dilution of the standard liquids. He examines whether, in spite of this great dilution, notable differences do not appear between the changes of volume of distilled water and those of the liquids used in titration, and has for this purpose made a series of experiments upon sixteen of the more important of these liquids, at temperatures ranging from 0° to 30°. He finds that, though the errors occasioned are not important, the rate of expansion of water differs in many cases very distinctly from those of standard solutions.

Remarks on the Determination of the Specific Gravity of Solids and Liquids.—Dr. G. Brügelmann.—The author proposes a method based on the use of a good balance and of a cylindrical graduated measuring instrument. For this purpose he recommends a Mohr's burette holding 50 c.c., and graduated in tenths of a c.c., or a Mohr's measuring pipette. For determining the sp. gr. of a liquid it is merely necessary to allow a suitable and adequately large volume to flow out of the burette and then to weigh. Solids are first weighed and then introduced into the burette, which contains a suitable liquid, and which is previously well dried internally above the level of the liquid by wiping with filter-paper. The difference in the level of the liquid before and after the introduction of the solid shows the volume of the weight employed. The author recommends, as the liquid to be employed, benzol, toluol, or xylol. Porous bodies must of course be finely pulverised.

On Certain Wines of the Vintage 1879.—F. Musculus and Dr. C. Amthor.—The authors prove that, contrary to the assertion of wine merchants, the inferior wines of bad seasons contain an abnormably high quantity of extract, acid, ash, and phosphoric acid. The extract is of a gelatinous consistence, arising from pectinoid matter not converted into sugar.

Potassium Permanganate and Chromic Acid as Absorbents for Nitric Oxide.—Dr. C. Böhmer.—The author raises the question whether the method of Sachsse and Kormann for the determination of amidic acids is not capable of simplification. The method is founded on the transformation of nitrous acid with monamides. In an aqueous solution and with fatty bodies in general the nitrogen gas liberated from the amide furnishes a measure for the quantity of the amidic substance. For absorbing the nitric oxide evolved from the nitrous acid, ferrous sulphate has been employed. Instead of this the author uses a solution of potassium permanganate obtained by stirring up a slight excess of the salt in water. This reagent in an alkaline solution serves for the simultaneous removal of nitric oxide and carbonic acid. If the latter is not to be removed, chromic acid does better service. The author recommends a freshly-prepared solution of 50 grms. in 100 c.c. dilute nitric acid.

Two New Methods for the Detection of Cadmium in Presence of Copper in a Systematic Qualitative Analysis.—A. Orlowski.—These two methods depend on the power of sulphur completely to precipitate copper from its oxide salts in presence of a sufficient quantity of stannous chloride, and on the behaviour of sodium hypo-sulphite with solutions of copper.

First Method.—The blue liquid obtained after removal of the bismuth hydroxide is acidified with hydrochloric acid, and stannous chloride is added until the colour is destroyed. Milk of sulphur is then added, and the whole is heated to boiling. All the copper is thrown down as a black precipitate of copper sulphide. Filter, and add ammonia, when the tin is deposited as stannic and stannous hydroxide, whilst cadmium hydroxide, which is at first thrown down, is re-dissolved by the excess of ammonia. Filter again, and test the filtrate with hydrogen sulphide. A yellow precipitate indicates cadmium.

Second Method.—The blue solution, after removal of bismuth hydroxide, is acidified with hydrochloric acid, mixed with sodium hypo-sulphite, boiled till the precipitate passes from a yellow to a dark brown (not black) and the liquid is colourless and transparent. If cadmium is present the characteristic yellow precipitate will appear on neutralising the filtrate with ammonia and adding ammonium sulphide. The author recommends the second method as the simpler and better adapted for general use.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 8.—London Institution, 5.
—— Medical, 8.30.
—— Society of Chemical Industry.
TUESDAY, 9th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
—— Institution of Civil Engineers, 8.
WEDNESDAY, 10th.—Geological, 8.
—— Microscopical, 8.
THURSDAY, 11th.—London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 12 h.—Quekett Club, 8.
—— Astronomical, 8.

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1207.

CHEMICAL NOMENCLATURE AND NOTATION.

The following instructions relating to these matters were addressed by the Council of the Chemical Society to the Abstractors in 1879,* and are now reprinted, with a few slight alterations, in the hope that they may have some influence in promoting uniformity of nomenclature and notation.

Nomenclature.

"1. Employ names such as *sodium chloride, potassium sulphate, ethyl acetate,* and use the terminals *ous* and *ic* only in distinguishing compounds of different orders derived from the same elementary radicles, *e.g.*, mercurous and mercuric chloride, sulphurous and sulphuric acid.

"2. Term compounds of metallic and alcoholic radicles with (OH), *hydroxides* and not hydrates, *e.g.*, potassium hydroxide, phenyl hydroxide, the name hydrate being reserved for compounds supposed to contain water of combination or crystallisation. Compounds such as CH_3ONa, C_2H_5ONa, $C_7H_{15}ONa$, &c., should be termed sodium methoxide, ethoxide, heptyoxide, &c.

"3. Apply the term *acid* only to compounds of hydrogen with negative radicles, such as HNO_3, H_2SO_4, H_3PO_4, and denote the oxides which form acids by names such as sulphuric anhydride or sulphur trioxide. Term salts containing an amount of metal equivalent to the displaceable hydrogen of the acid, *normal* and not neutral salts, and assign names such as hydrogen-sodium sulphate, hydrogen-disodium phosphate, &c., to the acid salts. Basic salts are as a rule best designated merely by their *formulæ*.

"4. Use names such as *methane, ethane,* &c., for the normal paraffins or hydrocarbons of the C_nH_{2n+2} series of the form $CH_3.(CH_2)_5.CH_3$. The isomeric hydrocarbons are usually most conveniently represented by names indicating their relation to methane: for example, $CH_3.CH_2.CH_2.CH_3$ = propylmethane; $CH_3.CH(CH_3)_2$ = isopropylmethane or trimethylmethane; or, although less frequently, by names such as diisopropyl.

"5. Term the hydrocarbons C_2H_4 and C_2H_2 *ethylene* and *acetylene* respectively (not ethene and ethine). Distinguish the homologues of ethylene, whenever possible, by names indicating their relation to it, such as methylethylene, dimethylethylene, &c., denoting the di-derivatives of the form $C_nH_{2n+1}.HC:CH.C_nH_{2n+2}$ as *a*-, and those of the form $CH_2:C(C_nH_{2n+1})_2$ as *β*-compounds: thus, $CH_3.CH:CH.CH_3$ = *α*-dimethylethylene; $CH_2.:C(CH_3)_2$ = *β*-dimethylethylene. Similarly, use names such as methylacetylene and dimethylacetylene for the homologues of acetylene of the form $CH:C.C_nH_{2n+1}$ and $C_nH_{2n+1}.C:C.C_nH_{2n+1}$. Adopt the name *allene* for the hydrocarbon $CH_2:C:CH_2$, and indicate the relation which its homologues bear to it in the same manner as pointed out for acetylene.

"6. Distinguish all alcohols, *i.e.*, hydroxyl-derivatives of hydrocarbons, by names ending in *ol*, *e.g.*, quinol, catechol, resorcinol, saligenol, glycerol, erythrol, mannitol, instead of hydroquinone, pyrocatechin, resorcin, saligenin, glycerin, erythrite, mannite. Compounds which are not alcohols, but which are at present distinguished by names ending in *ol*, may be represented by names ending in *ole*, if a systematic name cannot be given. For example, write indole instead of indol; furfuraldehyde instead of furfurol; fucusaldehyd instead of fucusol. Ethers derived from phenols, such as $C_6H_5.OCH_3$, &c., hitherto called anisol, anethol, &c., may be distinguished by names ending in *oil*, as anisoil and anethoil.

"Alcohols should be spoken of as mono-, di-, tri-, or n-*hydric*, according to the number of OH groups.

"7. Bodies such as the acids of the lactic series containing the group (OH) should be termed *hydroxy*-, and and not oxy-derivatives, *e.g.*, hydroxyacetic and not oxyacetic acid. Compounds containing the analogous groups, C_2H_5O, C_6H_5O, $CH_3.COO$, &c., should in like manner be termed ethoxy-, phenoxy-, acetoxy- derivatives. Thus ethoxy-propionic acid instead of ethyllactic acid; 3:4 diethoxybenzoic acid instead of diethylprotocatechuic acid; and acetoxypropionic acid instead of acetyllactic acid. Terms such as diethylprotocatechuic acid should be understood to mean a compound formed by the displacement of hydrogen-atoms in the hydrocarbon radicle of protocatechuic acid by ethyl, viz.,—

$$C_6H(C_2H_5)_2(OH)_2.COOH,$$

and not $C_6H_3(OC_2H_5)_2.COOH$, just as dibromoprotocatechuic acid is understood to be the name of a compound of the formula $C_6HBr_2(OH)_2.COOH$.

"8. The term *ether* should be restricted to the oxides of hydrocarbon radicles, and the so-called compound ethers should be represented by names similar to those given to the analogously constituted metallic salts (comp. 12).

"9. Compounds of the radicle SO_3H should, whenever possible, be termed *sulphonic* acids, or, failing this *sulpho-compounds:* as benzene sulphonic acid, sulphobenzoic acid, and not sulfi-compounds. Compounds of the radicle $SO_2.NH_2$ should be termed sulphonamides.

"10. Basic substances should invariably be indicated by names ending in *ine*, as aniline, instead of anilin, the termination *in* being restricted to certain neutral compounds, viz., glycerides, glucosides, bitter principles, and proteids, *e.g.*, palmitin, amygdalin, albumin. The compounds of basic substances with hydrogen chloride, bromide, or iodide, should always receive names ending in *ide* and not *ate*, as morphine hydrochloride and not morphine hydrochlorate.

Notation.

"11. Equations, as a rule, should *not* be written on a separate line, but should 'run on' with the text. Simple reactions involving a mere interchange of radicles, or the withdrawal or addition of a particular element or group of elements, need not generally be expressed by equations.

"12. To economise space it is desirable:—1, that *dots* should be used *instead of dashes* in connecting contiguous symbols or radicles, whenever this does not interfere with the clearness of the formula; 2, that formulæ should be shortened by the judicious employment of the symbols Me for CH_3, Et for C_2H_5, Pr^{α} for $CH_2.CH_2.CH_3$, Pr^{β} for $CH(CH_3)_2$, Ph for C_6H_5, $\overline{Ac}$ for $CO.CH_3$, and $\overline{Bz}$ for $CO.C_6H_5$; and 3, that formulæ should be written *in one line* whenever this can be done without obscuring their meaning. For example:—

$CCl_3.CH(OEt)_2$ instead of $CCl_3CH\langle^{OC_2H_5}_{OC_2H_5}$

$(CCl_3.CHOH)_2S$ instead of $\begin{matrix}CCl_3—CHOH\\ CCl_3—CHOH\end{matrix}\rangle S$

$CH_2:CH_2$ instead of $CH_2{=}{=}CH_2$

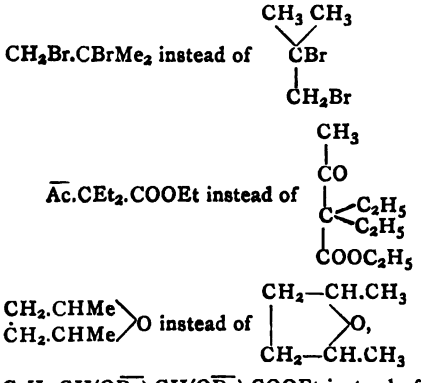
$CH:CH$ instead of $CH{\equiv}{\equiv}CH$

$CH:C.CH_2.CH_2.C:CH$ instead of $\begin{matrix}CH_2—C{\equiv}{\equiv}CH\\ |\\ CH_2—C{\equiv}{\equiv}CH\end{matrix}$

$MeCH:CHPr^{\alpha}$ instead of $CH_3.CH{=}{=}CH.CH_2.CH_2.CH_3$

$COOH.CH:CMe.COOH$ instead of $\begin{matrix}CH_3—C{=}{=}CH\\ |\quad\quad |\\ COOH\quad COOH\end{matrix}$

* See Chemical News, vol. xxxix., p. 146.

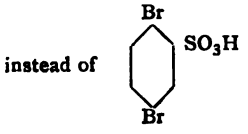


$C_6H_5.CH(O\overline{Bz}).CH(O\overline{Bz}).COOEt$ instead of $C_6H_5.CH(O.CO.C_6H_5).CH(O.CO.C_6H_5).COOC_2H_5$.

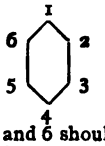
"13. In representing the constitution of benzene derivatives, as a rule, merely indicate the relative positions of the radicles in the symbol of benzene by figures, instead of by means of the hexagon symbol, as in the following example:—

Paradibromobenzenesulphonic acid,—

$C_6H_3Br_2.SO_3H[Br:SO_3H:Br=1:2:4]$



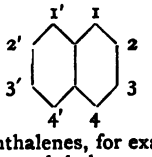
the figures always being used in the order



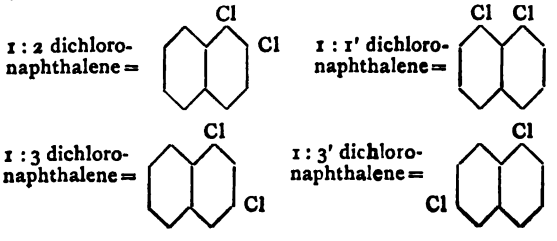
Relatively to the position 1, the positions 2 and 6 should always be spoken of as *ortho*-positions, 3 and 5 as *meta*-positions, and 4 as the *para*-position. It is better, however, in speaking of the derivatives of benzene, to express their constitution by giving them names such as 1:2 dibromobenzene, 1:3 dibromobenzene, &c., rather than by terming them ortho- or meta-dibromobenzene, &c.

"14. In representing the constitution of derivatives of other 'closed chain' hydrocarbons also, as a rule, do not employ graphic formulæ, but merely indicate the position of the radicles introduced, in the following manner:—

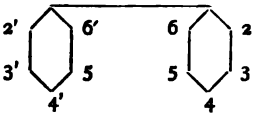
"*In the case of naphthalene*, express the position of the radicles introduced in place of hydrogen relatively to the carbon atoms common to the two 'rings,' and number the positions in the one ring 1, 2, 3, 4, and those in the other 1′, 2′, 3′, 4′ in the order shown by the annexed symbol:—



"The dichloronaphthalenes, for example, are spoken of simply as 1:2 dichloronaphthalene, or dichloronaphthalene [Cl:Cl=1:2, &c., thus:—



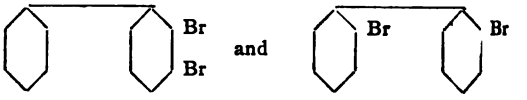
"*In the case of diphenyl*, indicate the position of the radicles relatively to the carbon atom of one C_6 group which is associated with the other C_6 group, and number the positions in the one group by the figures 2, 3, 4, 5, 6, and the corresponding positions in the other group by the figures 2′, 3′, 4′, 5′, 6′, as shown by the following symbol:—



Thus the mono-derivatives, the bromodiphenyls, for example, are represented as—

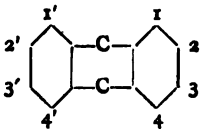
Bromodiphenyl [Br = 2]
" [Br = 3]
" [Br = 4]

and the two dibromodiphenyls—



are respectively dibromodiphenyl [Br:Br = 2:3] and dibromodiphenyl [Br:Br = 2:6′].

"*In the case of anthracene*, employ the following symbol, and indicate the position of the radicles relatively to the central C_2-group:—



Examples:—

Alizarin, $C_6H_4:C_2O_2:C_6H_2(OH)_2$[OH : OH = 1 : 2].
Quinizarin, $C_6H_4:C_2O_2:C_6H_2(OH)_2$[OH : OH = 1 : 4].
Anthraflavic acid,—
$C_6H_3(OH):C_2O_2:C_6H_3(OH$ [OH : OH = 2 : 3′].
Purpurin,—
$C_6H_4:C_2O_2.C_6H(OH)_3$[OH : OH : OH = 1 : 2 : 4].

"In speaking of compounds such as these, their constitution may be represented by the names—

1:2	Dihydroxyanthraquinone	= Alizarin.
1:4	"	= Quinizarin.
2:3′	"	= Anthraflavic acid.
1:2:4	Trihydroxyanthraquinone	= Purpurin.

"Always include the letters and figures indicating the constitution of derivatives of closed chain hydrocarbons in square brackets."

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

(Continued from p. 3.)

Separation from Silver.—1. In a very acid nitric solution the silver is removed by a slight excess of hydrochloric acid.

2. Sulphuretted hydrogen completely removes the silver contained in nitric solutions moderately acid, or in strongly acid hydrochloric liquids.

Separation from Gold.—The three following procedures are recommended:—

1. A current of sulphuretted hydrogen is passed into the decidedly acid solution.

2. The gold is reduced at a gentle heat by sulphurous acid and the precipitate washed with water acidified with a little hydrochloric acid.

3. The hydrochloric solution, decidedly acid, if brought in contact with divided copper, abandons the gold and retains the gallium. The operation takes place either in the cold or at a gentle heat.

Separation from Palladium.—The author has examined four methods, the two first of which give exact results.

1. The best process is to treat the decidedly acid hydrochloric solution with a prolonged current of sulphuretted hydrogen. The formation of palladium sulphide is slow in dilute solutions. After saturation with sulphuretted hydrogen in the cold, the liquid is kept for about a couple of hours at about 70°, and it is then ascertained that the filtrate, on submission to the same treatment, does not become coloured. It is advantageous to operate upon concentrated liquids, and to conentrate by evaporation before the final treatment with sulphuretted hydrogen, thus expelling the too great excess of hydrochloric acid.

2. Divided copper is placed in a moderately acid hydrochloric solution. In the cold the reduction of the palladium is complete, but slow, and it is better to operate about 80°. The palladium obtained is free from gallium, or contains sometimes an insignificant trace. Nevertheless, palladium reduced by zinc, as is mentioned below, retains energetically a small quantity of gallium. In view of this discrepancy, and fearing an error, the author effected repeated and carefully the reduction of palladium by means of copper in liquids containing gallium, and on each occasion the absence of copper in the precipitate was ascertained. The palladium is deposited upon the copper in brilliant, compact layers, and during the reaction there is no escape of gas. Zinc, on the contrary, occasions a brisk escape of hydrogen, and the palladium appears in the form of a black powder, of porous aspect, acting perhaps upon the salts of gallium as does animal charcoal upon certain soluble bodies. Perhaps the hydrogenation of the reduced metal plays a part in the phenomenon observed.

3. Zinc quickly throws down palladium from a distinctly acid hydrochloric solution, but the reduced metal, though washed in water acidified with hydrochloric acid, retains a little gallium.

In one experiment, 0·005 grm. gallium and 0·25 grm. palladium were brought into the state of very acid chlorides. In contact with zinc the solution yielded a metal containing a portion of gallium. This galliferous palladium, transformed into a chloride, was again treated in the same manner. The new precipitate, still containing sensible traces of gallium (though less than the first) was again converted into chloride and submitted to the action of zinc. The last metal still retained gallium, the quantity of which was merely diminished from the first to the third precipitation.

4. Palladium is often separated from other metals by evaporating the solution in *aqua regia* almost to dryness, after the addition of potassium chloride. The mass is then re-dissolved in alcohol of 85 per cent. This process, convenient in certain cases only, permits of an approximate analysis of mixtures of palladium and gallium, since sensible traces of gallium remain in the potassium palladio-chloride, and of palladium in the alcoholic liquid.

Separation from Platinum.—The only exact process is the precipitation of platinum by sulphuretted hydrogen in a decidedly acid hydrochloric solution. The formation of platinum sulphide is very slow, especially in the cold, but it may be accelerated by heating. We may saturate with sulphuretted hydrogen in the cold and raise the liquid slowly to near boiling, repeating this treatment eight or ten times in succession. Or after having saturated the liquid with sulphuretted hydrogen in the cold it is heated to about 70°, and kept at this temperature for some hours, whilst still traversed by a slow current of sulphuretted hydrogen.

The filtered solution is then mixed with the washing waters and concentrated, thus eliminating the bulk of the hydrochloric acid, a little of which in the free state ought to remain. It is then treated with sulphuretted hydrogen for some hours in heat; if there is no colouration the platinum has been entirely eliminated.

2. An approximate separation is obtained by precipitating the platinum with ammonium chloride in a hydrochloric solution, distinctly acid, and mixed with alcohol. The filtrate carries off a little platinum, but the ammonium platino-chloride does not appear to retain appreciable quantities of gallium.

3. Copper reduces the platinum, but it is difficult to obtain a complete reaction even in heat. On the contrary, a distinctly acid solution of platinum chloride is entirely reduced by zinc, the action being much more rapid in heat than in the cold. A few drops of hydrochloric acid are added from time to time to keep up a brisk escape of hydrogen. The platinum thus precipitated retains gallium with a persistence even exceeding that mentioned above in the case of palladium. The reduction with zinc must be repeated a great many times in order to remove all the gallium. The use of zinc is therefore very inferior to that of sulphuretted hydrogen.—*Comptes Rendus*, vol. xcv., p. 1332.

NOTE ON ASBESTOS FILTERS.

By P. CASAMAJOR.

An extensive dealer in wares used by chemists lately informed me that he had many inquiries concerning asbestos for filtering liquids in chemical analysis. Some chemists complain that they cannot get clear solutions through asbestos, while others, who obtain clear solutions, find that their liquids filter altogether too slowly.

Allow me to recall that the method of making asbestos filters, by pouring a thin paste of this material over a perforated platinum disc, was first proposed by me in 1875,* but I neglected to give directions concerning the preparation of asbestos, to make it fit for filtering liquids in chemical analysis. It now appears, however, that such directions would be found useful, and I propose to repair the omission and give the necessary details.

The kind of asbestos to use is a matter of some importance. I have tried three kinds, which are sold by dealers in New York as the *Canadian*, the *Italian*, and the *Australian*. This last is less flexible than the other two, and consequently the fibres do not felt together and pack as closely on the perforated plate. Hence liquids filter more rapidly, and the Australian is, on this account, preferable to the other two kinds. I am informed that the Canadian asbestos is the most soluble in acids, but I have not verified the assertion.

Whatever may be the kind of asbestos used the following is a process for obtaining, with little trouble, a quantity of the pulp in a fit state for filtration:—

A coarse brass sieve is placed over a sheet of paper, and a handful of asbestos is rubbed pretty roughly over the sieve cloth. This breaks it up in such a way that the smaller fragments pass through the meshes, and are deposited on the paper underneath. After a while the portion which remains on the sieve cloth is collected in one bundle, and rubbed again in the same manner, and the operation is repeated until a sufficient quantity has gone through. In a few minutes enough of the material is obtained to last for months.

As to the coarseness of mesh to use, I may say that I have used No. 10 sieve (ten openings to the inch) with satisfactory results. The sieve is best placed bottom up, so as to leave plenty of room under the cloth.

The next operation is to free the sifted material from dust, and from the finest particles. This is easily accomplished by placing the asbestos, as obtained above, over another sieve of finer mesh (about No. 25 or No. 30), and stirring it while water is poured over the sieve. The first

* See *American Chemist*, v., p. 44; Chemical News, xxxii., p. 46.

water which passes through is quite milky, but it gradually becomes clearer as the washing is continued. The washed asbestos is then put in a beaker glass, and boiled for about half an hour with strong hydrochloric acid (about 1 part of fuming HCl to 4 parts of water).

The pulp, after this treatment, is poured over a perforated platinum plate placed in a funnel,* and washed with distilled water until no acidity is shown by litmus-paper. The pulp is then taken out of the funnel and strongly heated in a platinum dish. After letting it cool sufficiently it may be placed in a wide-mouth bottle for future use.

DETERMINATION OF THE FOREIGN ELEMENTS CONTAINED IN "WORK COPPER."

By Prof. R. FRESENIUS.

1. Treat 100 grms. of the carefully cleaned sample with a sufficiency of pure nitric acid of sp. gr. 1·20—adding water in case of copper turnings—until no further action takes place in heat, dilute with water, filter and wash the undissolved residue. The filtrate is collected in a tared measuring-flask holding 2 litres.

2. The residue is washed into a porcelain capsule, the ash of the filter is added; the whole is evaporated to dryness, placed in a porcelain crucible, any particles adhering to the capsule being rubbed off with sodium carbonate and added to the rest. Sodium sulphide is added, the whole fused, with exclusion of air, and treated with water when cold; the yellow solution is filtered from the black residue, and the latter is washed.

3. The black residue obtained in No. 2, together with the filter, is heated with moderately dilute nitric acid, filtered, washed, the filter burnt, the ash heated with nitric acid, diluted, filtered, the filtrate mixed with the solution previously obtained, the filter is incinerated, and the ash—which may contain a portion of gold—is preserved. The solution is mixed with a little hydrochloric acid. If a precipitate of silver chloride is formed it is let deposit, filtered, and converted into metallic *silver*, which must ultimately be tested as to its purity. The solution, after removal of the silver chloride, if any, is evaporated along with sulphuric acid for the separation of *lead*. From the filtrate *bismuth*, if present, is thrown down by means of sulphuretted hydrogen, and from the filtrate any metals of the fourth group are precipitated with ammonium sulphide.

4. The sulphide solution obtained in No. 2 is precipitated with hydrochloric acid; the precipitate, containing much sulphur, is treated, along with the filter, with hydrochloric acid containing bromine, till everything soluble is dissolved. Filter, wash, remove any free bromine by means of ammonia, acidify with hydrochloric acid, precipitate at 70° with sulphuretted hydrogen, separate the metallic sulphides by precipitation, dissolve them in slightly yellowish ammonium sulphide, filter, evaporate the solution to dryness in a porcelain crucible, oxidise the residue carefully with fuming nitric acid, evaporate to dryness, add sodium hydrate and a little sodium nitrate; melt and separate antimony, tin, and arsenic, if all present, according to H. Rose's method. The small filters in which the solution of the metallic sulphides in ammonium sulphide, and the solution of sodium antimoniate in hydrochloric and tartaric acids have been filtered, are incinerated after washing, and the ash, mixed with that previously reserved, is treated with *aqua regia*. Dilute, filter, evaporate with hydrochloric acid to expel the nitric acid, and from the residue concentrated to a small volume precipitate gold by means of ferrous chloride. If tin is not present, antimony and arsenic are better separated according to Bunsen's method; in the solution obtained by brominised hydrochloric acid after removing the free bromine with ammonia. In this case the weighed metallic sulphides must be tested for gold.

5. One litre of the liquid obtained in No. 1, corresponding to 50 grms. copper, is mixed with 4 drops of hydrochloric acid. If a turbidity or a deposit of silver chloride is formed, it is allowed to settle while hot, and a further drop of hydrochloric acid is added, observing if all the silver is precipitated. If a turbidity is occasioned a few more drops of hydrochloric acid must be added, avoiding any appreciable excess. The silver chloride is most conveniently converted into metallic silver for weighing. The quantity found, if doubled and added to that obtained in No. 3, gives the percentage of silver.

6. The solution from No. 5 not rendered turbid by hydrochloric acid, or filtered from a precipitate of silver chloride, is placed in a porcelain capsule, cautiously mixed with 85 grms. pure concentrated sulphuric acid, which has been previously diluted with water, evaporated till all nitric acid is expelled, mixed with water, heated till all the copper sulphate is dissolved, and the liquid then filtered into a 2-litre measuring-flask. The undissolved residue of lead sulphate is washed, first with water containing sulphuric acid, and then with alcohol, which is collected separately. It is then weighed, and tested for its purity by boiling it with a solution of ammonium acetate containing a little free ammonia. If an insoluble residue is left after repeated boiling it must be deducted from the lead sulphate and further examined.

7. The solution obtained in No. 6, separated from the lead sulphate by filtration, is made up to 2 litres, mixed, ½ litre of the solution is introduced into each of four boiling-flasks, containing 1½ litre, the contents of each are diluted with about ½ litre water, and to each is added 50 c.c. hydrochloric acid of sp. gr. 1·12. They are heated to 70°, and the copper is precipitated with sulphuretted hydrogen. The contents of the four flasks, when cold, are introduced into a tared 6-litre flask with a ground stopper: the boiling-flasks are repeatedly rinsed out with sulphuretted hydrogen water, so that their entire contents are brought into the large flask, which after thorough mixing is weighed. If from the gross weight is deducted that of the empty flask and that of the copper sulphide (as calculated from the metallic copper), we obtain the weight of the solution in the flask. After the precipitate has settled, the supernatant liquid is drawn off as completely as possible: the flask with the precipitate and the remainder of the solution is weighed, and the weight of the liquid drawn off is thus found. The latter is filtered, evaporated in a porcelain capsule until the sulphuric acid is nearly all driven off; heated again with a little nitric acid, mixed with ammonia, filtered, the residue dissolved in hydrochloric acid, and again precipitated with ammonia. In the precipitate any *iron* present is determined preferably by precipitation with ammonium sulphide from the solution mixed with tartaric acid and ammonia, and converting the iron sulphide into iron oxide in the ordinary manner. From the filtrate, after addition of ammonium acetate and acidulation with acetic acid, *nickel*, *cobalt*, and *zinc* are precipitated, if present, and separated and determined as usual. The quantities of iron, nickel, cobalt, and zinc present in the whole of the solution are then calculated.

8. To the precipitate, together with the residue of the solution left in the large flask, is added caustic soda-lye till the liquid has a strong alkaline reaction. A solution of sodium sulphide containing some disulphide is then added in sufficient quantity, so that all antimony and arsenic sulphides may be dissolved, and the whole is gently heated for some time. It is then considerably diluted with water, mixed, weighed; the liquid is drawn off as far as possible, the flask with the rest of its contents is weighed, and the quantity of the liquid drawn off is thus ascertained. It is filtered, acidulated with hydrochloric acid,

* A perforated platinum disc, having a stout platinum wire soldered with gold in the centre of the disc, can be used in an ordinary conical funnel. The wire finds its place in the stem of the funnel, and keeps the perforated plate in position. (See CHEMICAL NEWS, xlvi, p. 8.) A Gooch crucible of sufficient size may also be used for the same purpose.

and let settle. As has been laid down in No. 7, it is easy to calculate the quantity of copper from which the metallic sulphides of the sixth group precipitated from the solution containing the alkaline sulphides are derived. As they are mixed with a large excess of sulphur, the precipitate, after settling, is filtered, washed, treated whilst still moist with hydrochloric acid containing bromine, diluted, filtered, mixed with ammonia till the solution has become colourless, and then, after a gentle but prolonged heating, with hydrochloric acid. From the clear solution the metals of the sixth group are precipitated by means of sulphuretted hydrogen and separated, as recommended in No. 4. The quantities obtained are calculated for the whole weight.

9. The precipitate of copper sulphide obtained in No. 8 from the main quantity of the liquid containing the alkaline sulphides is brought upon the filter through which the liquid has been passed, washed with water containing sodium sulphide, dissolved in hydrochloric acid with the addition of nitric acid, and filtered, the solution, with the addition of hydrochloric acid in excess, is evaporated to dryness upon the water-bath, the saline mass taken up in water, and filtered. The insoluble residue containing all the bismuth as a basic chloride is dissolved in hydrochloric acid, potassa is added until the liquid is alkaline, then potassium cyanide in some excess, and potassium sulphide. The bismuth is separated as sulphide, whilst the copper entangled with it remains in solution. As the bismuth sulphide may contain nickel sulphide, it is dissolved in nitric acid, the diluted solution precipitated with sulphuretted hydrogen, and the pure bismuth sulphide is either weighed as such, or converted into bismuth oxide.

10. 400 c.c. of the solution obtained in No. 1, representing 20 grms. copper, are mixed with ammonia till the greater part of the free nitric acid is neutralised. A few drops of solution of barium nitrate are added, and the whole is let stand for some time in a warm place. If the copper contains appreciable traces of sulphurous acid there appears a slight precipitate of barium sulphate, which is filtered off, and determined. Very minute traces of sulphurous acid cannot be discovered in this manner, since barium sulphate is not quite insoluble in the solution of copper nitrate. For detecting very small quantities the copper must therefore be treated according to Hampe's directions in a current of chlorine. In constructing the apparatus vulcanised caoutchouc tubing is inadmissible.

11. 400 c.c. of the solution in No. 1, representing 20 grms. copper, are repeatedly evaporated with hydrochloric acid, in order to expel nitric acid, diluted with 1200 c.c. of water, precipitated with sulphuretted hydrogen at 70°; the whole introduced into a tared 2-litre flask, into which the capsule is rinsed, and the liquid is mixed and weighed. It is let settle, as much as possible of the supernatant liquid is drawn off, the flask with the precipitate and the residue of the solution is weighed, thus showing what quantity of copper corresponds to the liquid drawn off (compare No. 7). It is filtered, evaporated to a small volume with repeated additions of nitric acid, and any phosphoric acid present (due to the presence of phosphorus in the copper) is determined by the molybdic process.

12. For the determination of oxygen and for ascertaining the state of combination of the foreign elements, the author refers to Hampe's memoir in the *Zeitschrift für Berg. und Hütten Wesen*, 27, p. 205.—*Zeitschrift für Analyt. Chemie*, 21, p. 229.

Determination of Proximate Constituents.—For the determination of the free acids in fatty oils Burstyn and Langier have proposed methods which consist in extracting the free acid by agitation with alcohol at 90 per cent and titrating the solution. The assumption that the oil entirely dissolves in the alcohol is incorrect. Hofmann and Geissler propose to dissolve the oil in ether and to titrate with an alcoholic solution of potassa.—*Zeitschrift.*

NEW VOLUMETRIC DETERMINATION OF POTASSIUM DICHROMATE, AND ITS USE IN THE TITRATION OF THE CAUSTIC ALKALIES.

By M. RICHTER.

Potassium dichromate is an acid salt, and in contact with caustic potassa passes into 2 mols. of the monochromate.

The dichromate to be examined is dissolved in water, and mixed with very little phenol phthaleine, which separates out as it is dissolved in alcohol. Large quantities of phenol phthaleine are to be avoided as the final reaction would be delayed.

In titration, a potassa solution must be used which has been standardised with sulphuric acid, and the action of which in comparison with sodium carbonate has been determined with phenol phthaleine, for the litmus colour is not sufficiently sensitive and distinct.

As the potassa falls into the solution of the dichromate the orange colour of the latter passes first into the yellow of the mono-chromate, and then, as in the titration of chlorine with a silver solution, each drop of the potassa produces a red spot which disappears on gentle agitation. At the conclusion of the reaction the red colour remains decidedly longer. It must not be supposed that the titration is at an end, for this phenomenon depends merely on the suspension of the phenol phthaleine in the liquid. We cease with a faint yellowish red colouration and use as comparison a solution of the mono-chromate of the same degree of concentration (1 grm. in 150 to 200 grms. water). The transit from the full yellow to the reddish yellow colour is easily recognised. By means of this method of determining chromic acid in alkaline dichromates, and of the author's process for its titration in the mono-chromate with silver nitrate and back-titration with sodium chloride, it is possible to determine mono- and dichromates when they occur together. The method is more than sufficiently accurate for technical purposes.

The author recommends the inverse use of this method, employing potassium dichromate for titrating potassa, soda, and ammonia. Two advantages of this method are that the dichromate occurs pure and anhydrous, and that the solution retains its standard for years.—*Zeitschrift für Anal. Chemie.*

NOTE ON THE AMMONIA-PROCESS FOR WATER ANALYSIS.

By CHARLES W. MARSH.

The present article contains the results of some investigations in connection with the systematic examination and comparison of various methods of water analysis. Among other questions presented for examination was that of the possible loss of volatile organic matter during the evaporation and boiling of water, necessitated by the ammonia and other processes. At the suggestion of Prof. Cornwall the series of experiments in Table I was begun last fall. After the experiments had been nearly completed, a copy of a "Report on a Peculiar Condition of the Water of Boston in November, 1881," by Prof. Ira Remsen, was received, in which it was found that Prof. Remsen had already anticipated the results here given in his report, in which he says: "Another fact which came out in the examination of the Baltimore water was this: When free and 'albumenoid ammonia' were determined by the method already described, the amounts of the two added together were found to be considerably smaller than the total ammonia found when the oxidising mixture was added at the beginning of the operation, before the water was boiled. This clearly indicated that in the first stage

of the process, as usually conducted, there passed over with the free ammonia some nitrogenous substance capable of yielding ammonia with permanganate of potash. As this distillate had a strong odour, something like the 'cucumber odour,' the suggestion was made that the odour of the water was due to the presence of some volatile nitrogenous substance, the special nature of which could not be determined. The examination of the Farm-pond water confirms this idea. One example will make this clear, and will suffice: a specimen of Farm-pond water gave, when examined in the usual way, 0·034 free and 0·274 albumenoid ammonia, making a total of 0·308 parts of ammonia in 1,000,000 parts of water. When the same water was treated at the outset with the oxidising mixture, it gave a total of 0·506 part of ammonia. There remains here the difference between 0·308 and 0·506 to be accounted for, or two-fifths of the total. The material capable of yielding this lost ammonia was undoubtedly lost in the distillations of the water for free ammonia, and it must hence be a volatile nitrogenous substance."

The analyses in Table I. may still prove of interest, both as verifying his statement and illustrating the great variability in the proportion of organic matter which may thus be lost. Twenty-six analyses were made on different waters, proceeding in the following manner:—The analysis for free and albumenoid ammonia was made as Wanklyn directs. Then 300 c.c. were taken (the same quantity remaining in the retort when the permanganate of potash is added in the regular analysis), and 50 c.c. of permanganate were added, and three distillates of 50 c.c. each were taken off and nesslerised, and the whole calculated to 1 litre. This gave the total ammonia. In only one case did the sum of the free and albumenoid ammonia exceed the total ammonia. In three cases the results were identical, and in the other twenty-two the total ammonia was more than the sum of the free and albumenoid ammonia. In Table I. in the first column is the free ammonia: in the second the albumenoid ammonia; in the third the sum of the two; in the fourth the total ammonia; and in the fifth the difference between the total ammonia and the sum of the free and albumenoid ammonia.

TABLE I.

No.	Specimen.	Free Ammonia.	Albumenoid Ammonia.	Sum of Free Ammonia and Albumenoid Ammonia.	Total Ammonia.	Difference bet. Sum of Free Ammonia and Alum'oid Am. and Total Am.
1	Well Water ..	0·04	0·15	0·19	0·29	0·10
2	,, ,, ..	0·05	0·20	0·25	0·35	0·10
3	,, ,, ..	0·05	0·10	0·15	0·18	0·03
4	Cistern ,, ..	0·01	0·07	0·08	0·10	0·02
5	,, ,, ..	0·01	0·06	0·07	0 07	0·00
6	,, ,, ..	0·09	0·07	0·16	0·18	0·02
7	Well ,, ..	0·46	0·07	0·53	0·56	0 03
8	Canal ,, ..	0·01	0·20	0·21	0·21	0·00
9	Distilled water ..	0·36	0·03	0·39	0·49	0·10
10	Well Water ..	0·01	0·04	0·05	0·07	0·02
11	,, ,, ..	0·06	0 08	0·14	0·16	0·02
12	Spring ,, ..	0·05	0·08	0·14	0·15	0·01
13	Surface ,, ..	8·10	1·75	9·85	10·12	0·27
14	,, ,, ..	2·84	1·46	4·30	4·10	*0·20
15	,, ,, ..	8·48	2·12	10·60	11·11	0·51
16	Cistern ,, ..	0·07	0·08	0·15	0·18	0·03
17	Well ,, ..	0·02	0·16	0·18	0·20	0·02
18	,, ,, ..	0·02	0·07	0·09	0·10	0·01
19	,, ,, ..	0·01	0·02	0·03	0·07	0·04
20	Spring ,, ..	0·01	0·02	0·03	0·06	0·03
21	Well ,, ..	0·02	0·03	0·05	0·06	0·01
22	,, ,, ..	0·11	0·11	0·22	0·24	0·02
23	,, ,, ..	0·01	0·04	0·05	0·10	0·05
24	,, ,, ..	0·16	0·11	0·27	0·34	0·07
25	,, ,, ..	0·07	0·08	0·15	0·20	0·05
26	,, ,, ..	0·04	0·08	0·12	0·12	0·00

The ammonia is expressed in parts per million.

It will be seen from the table that No. 14 was the only water where the sum of the free and albumenoid ammonia was greater than the total ammonia. This exceptional result may well be ascribed to the greater difficulty of accurately estimating the ammonia in highly coloured nesslerised solutions, and to the fact that any actual errors of this kind were increased in calculating the results, since it was necessary to dilute the specimen very largely with water free from ammonia. In Nos. 5, 8, and 26 it appears that no volatile nitrogenous substance escaped, as will be seen from the last column. All the other waters show different amounts of gain of the total ammonia over the sum of the free and albumenoid ammonia, some slight and some comparatively very large. The results in the table conclusively prove that something escapes conversion into ammonia. Is this something which escapes condensation, or will it be found in the distillate? To decide this question 500 c.c. of the water were boiled as usual to obtain a distillate of 200 c.c., containing, according to Wanklyn, all the free ammonia. This distillate was re-distilled with a proportionate amount of permanganate (33 c.c.), and two distillates of 50 c.c. each were obtained and nesslerised, the result being doubled to bring it up to one litre. This gave all the free ammonia and any ammonia which may come from the action of the permanganate on any condensible nitrogenous, organic compound, which had come over with the free ammonia. The ammonia from these two sources is given in the next to the last column Table II. In this table are the results of analysis on ten samples of water. In the first four columns the data are the same as in Table I. In the fifth column is the free ammonia and the ammonia which we have regained. In the sixth column is the sum of the albumenoid ammonia and the ammonia in the fifth column.

TABLE II.

No.	Specimen.	1. Free Ammonia.	2. Albumenoid Ammonia.	3. Sum of Free Am. and Album'oid Am.	4. Total Ammonia.	5. Sum of Free Am. and Regained Am.	Sum of 2 and 5.
1	Well Water	0·04	0·10	0·14	0·19	0·06	0·16
2	,, ,,	0·05	0·10	0·15	0·16	0·06	0·16
3	,, ,,	0·05	0·08	0·13	0·17	0·09	0·17
4	,, ,,	0·04	0·07	0·11	0·12	0·06	0·13
5	,, ,,	0·04	0·07	0·11	0·12	0·05	0·12
6	,, ,,	0·05	0·22	0·27	0·27	0·05	0·27
7	,, ,,	0·03	0·12	0·15	0·17	0·06	0·18
8	,, ,,	0·04	0·03	0·07	0·08	0·05	0·08
9	Cistern ,,	0·05	0·11	0·16	0·22	0·08	0·19
10	Well ,,	0·02	0·08	0·10	0·15	0·07	0·15

The ammonia is expressed in parts per million.

It would appear that in the case, at least, of specimens Nos. 2, 3, 5, 6, 8, and 10, the excess of ammonia obtained where the whole of the water was distilled with the permanganate directly, over the sum of the free and albumenoid ammonia as usually obtained, was due to some volatile, condensible, nitrogenous compound, from which as much ammonia could be obtained by the action of boiling permanganate after its distillation from the original water, as before. In Nos. 1 and 9 the sum of the albumenoid ammonia and the ammonia from the re-distillation is less than the total amn onia, hence some of the constituents escaped in the first distillation. In Nos. 4 and 7 the sum of the two ammonias in the sixth column is slightly greater than the total ammonia, which may be due to error of reading; at all events these two waters would show that all the ammonia was regained.

It is possible that the modification of the usual ammonia-process which is obviously suggested by the foregoing experiments may reconcile the differences now existing

between the organic purity of water as determined by the ammonia-process, and the oxidation process with permanganate (Forchammer's and its modifications). Work in this direction is now going on.—*American Chemical Journal*, vol. iv., No. 3.

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REPORTS ON THE EXAMINATION OF THAMES WATER.*

It will add to a clear understanding, in following the reports on the examination of Thames water, to forestall a statement respecting the results towards which "examination" is now directed, since it is only after reading through the special reports between 1828 and 1874, and the continuous reports to the Registrar-General since 1857, and the many others incorporated in the reports of the Water Examiner since 1873, that it becomes apparent what are the points which are held to be the most important to determine. It is now considered that the most important calculation that has to be made is the amount of organic matter, of animal origin, present in the water. Most of the early analyses of waters, even after the foundation of the Chemical Society in 1841, are those of natural "mineral waters," and the organic matter is generally considered to be sufficiently accurately determined by reference to "a trace." When the Thames water was first officially analysed by Dr. Bostock, and by Dr. Lamb for the Royal Commission of 1827,† the former dismisses organic matter with this remark:—"The remainder" (after the saline matters in a residue have been calculated) "may be considered as consisting of animal and vegetable remains." Dr. Lamb, however, though not seeing how to do more than Dr. Bostock did, has recorded his own, and probably other, chemical opinions in this form:—"It appears to be acknowledged that, in the examination of the properties of a water applied to dietetic uses, the principal object of enquiry should be whether the water, being impregnated with organic matter in a state of decomposition, this matter may be either of vegetable or animal origin; but I do not know that we possess any criterion to determine, with absolute certainty, whether matter, which may be discovered, and which is decidedly of organic origin, was derived originally from one or the other of these species." This, the first recorded recognition of the importance, though written fifty-five years ago, might equally well have been written this year only. The "absolute certainty" is a degree of certainty now, of necessity, from the refinement of modern appliances, very different from what it was then, but the very improvements in methods and manufacture of apparatus and manipulative accuracy have shown the uncertainties of progressive expected certainties, and the "absolute certainty" is not yet reached. One of the greatest points of interest in tracing the history of water analysis is the development of the methods for attempting to determine the amount of organic matter in a water, and more recently the attempts to determine whether what is present is of animal or vegetable origin. And this, too, is of interest to observe the lapse of time that has occurred between the recognition of the need of certain determinations of detail and the invention of a method for making them.

The need for such determinations has come to be shown from a combination of pathological, œtiological, and statistical inquiry, and has now probably a very different significance from what it had for Dr. Lamb.

Forty years later, the same view that Dr. Lamb had was, in "Watts's Dictionary of Chemistry" (1868), expressed:—"The presence of dissolved organic substance in water has, probably, a much greater influence in determining its fitness for dietetic purposes, &c."

Ten years later still, Dr. Tidy, in a paper read before the Chemical Society (1878), on "The Processes for Determining the Organic Purity of Potable Waters," wrote:—"Without stating definitely that I should be justified in expressing numerically the ratio of animal to vegetable matter by this means, I am not without hopes I shall be able to do so before long with considerable accuracy." Many other analysts have expressed the same opinion of uncertainty with regard to different processes, and no one claims "absolute certainty."

It will be convenient to first state what the reports are, and how and when they have appeared.

Leaving for the present the consideration of the steps which had led up to the examination of the waters of the London companies by order of Act of Parliament, the facts immediately connected with it are these:—

The Metropolis Water Act (1852)* had included the following clause, which was the first attempt at legislation with regard to the quality of water the companies should supply (Clause 4):—"From and after the thirty-first day of December, one thousand eight hundred and fifty-four every company shall effectually filter all water supplied by them within the metropolis for domestic use, before the same shall pass into the pipes for distribution, excepting any water which may be pumped from wells into a covered reservoir or aqueduct without exposure to the atmosphere, and shall not be afterwards mixed with unfiltered water." The enforcement of this (together with the enforcement as to quantity) depended upon Clause 9, which provided, "If at any time complaint as to the quantity or quality of the water supplied by any company be made to the Board of Trade by memorial in writing signed by not less than twenty inhabitant householders . . . &c., it shall be lawful for the Board of Trade . . . to appoint a competent person to inquire into and concerning the grounds of such complaint, &c." Clauses 12 and 13 provide that if the complaint shall appear well founded, the company shall remove the grounds of such complaint under penalty (Clause 16) of £200, with £100 a month in case of delays.

The two sets of investigations made for the Board of Health in 1856 were to ascertain how far the regulations of the Act had been carried out. The Act, it appears, did not have the desired effect. No definition was given of what "effectually filter" should mean, it is true; but still the water to be supplied was often pronounced by Prof. Frankland, in his monthly reports to the Registrar-General, unfit for domestic use. In Prof. Frankland's annual report for 1870 it is reported that the condition of the water is such as to "almost lead to the conclusion that Clause 4 had been repealed."

A change as to power of examination was made by the Metropolis Water Act, 1871, by which the examination was not left dependent on the complaint of twenty householders. Clause 35 of that Act provided that the Board of Trade may, at any time, if and when they think fit, appoint a competent person to inquire into and report on the quality of the water furnished by any company, notwithstanding that no complaint, &c. [Notice that quantity was not included, and quality was taken to mean more than merely "efficiently filtered."] Clause 36 provides, "There shall be a Water Examiner . . . who shall from time to time, in such manner as the Board of Trade direct, examine the water supplied by any company, in order to ascertain whether or not the company have complied with the requirements of Section IV. of the Metropolis Water Act, 1852, &c., and shall from time to time report, &c.† It will be noticed that Clause 36 applies to examining with reference to "effectual filtration," while

* From the *Journal of the Society o Arts*.

† Royal Commission, 1827 [Roget, Brand, and Telford], on quality and salubrity of water supplied to the metropolis. Report dated April 21st, 1828.

* 15 and 16 Vict., c. 84. "An Act to make better provision respecting the Supply of Water to the Metropolis;" short title, "Metropolis Water Act, 1852."

† Strange as it may appear to some, the official channel for the reports was the Under Secretary of the Railway Department, Board of Trade.

Clause 35 provides vaguely for examination of "quality." It is not apparent whether two officers were intended, whether by "quality" chemical quality was meant, or only quality as regards absence of such suspended matters as efficient filtration should remove. As a matter of practice "the Water Examiner," Colonel Bolton, reports on the filter beds, and on whether water is clear or turbid after filtration, while Prof. Frankland, who reports on the chemical analysis of the waters, also reports on the efficiency of filtration. In the Session of 1882 it was resolved to transfer the power conferred upon the Board of Trade to the Local Government Board. [On Prof. Frankland's reports see below, under Reports to Registrar-General.]

The Reports of the Water Examiner.

The monthly report is given in a tabulated form, in a single sheet, which, since the enlargement in 1873, is about 25 ins. by 20 ins.

The annual reports are to be found in Parliamentary Papers, as appendices in Local Government Board Reports.

Colonel Bolton's reports, therefore, contain the official account of the examinations made to ascertain how far the requirements of Clause 4, of the Act of 1852, have been carried out. They also show how far the constant supply provisions of the Act of 1871 have been adopted. They rest on totally different ground. The requirements of "efficient filtration," whatever that may mean, are imperative. Those of "constant supply" depend upon the proportion of houses in a district which adopt the fittings suitable for the pressure of a constant supply (see Sect. 10, Act of 1871). Constant supply has been referred to in a previous notice. In addition to the official report which Colonel Bolton gives, a number of other matters are referred to in his monthly reports.* For example, in his 1876 report, he states the duties of "Water Examiner," omitting, however, but without explanation why, all reference to the duties as to reporting on constant supply, and then continues—"In addition to inspecting the filter beds and reservoirs, and examining the quality of the water both at the intake and after filtrations at the works, I have included in my reports the following information and particulars, &c., &c." Where an Act of Parliament is not explicit there is always latitude allowed to those who have the practical interpretation of it. The information given, "in addition," is valuable; but there are obvious reasons for drawing a distinction between what is reported as important by the consensus of Parliamentary opinion, and what is reported on individual opinion as of importance. Most competent judges will agree that much of the information so given should be given as a report in accordance with some clause in an Act; but, for the present, that distinction must be drawn.

With regard to the expression "efficient filtration," and in the absence of any definition, Colonel Bolton writes—"Efficient filtration depends upon—

"1. A sufficient area of properly constructed filter beds, constantly cleaned, and fresh sanded.

"2. The rate of filtration being controlled and limited to a certain speed.

"3. The water delivered into the filter beds having been previously stored on subsidiary reservoirs, and the capacity of these reservoirs being such as to avoid the intake of turbid and muddy water during the time of extraordinary floods, which tend to foul and choke the filters."

The manner of reporting on the efficiency of filtration is to state whether the samples of water examined are clear, slightly turbid, turbid, or very turbid. Nowhere, however, is there any explanation given as to what is the standard or the scale followed.

* As a matter of fact the monthly reports, though referred to in the annual reports, have been apparently nowhere preserved, unless by some unknown collector.

Monthly Reports.

When the monthly reports were commenced, and up to 1876, only one sample a month from each of the companies was examined. In February, 1876, and since then, there have been daily samples of the water of each company reported on in this manner. In addition to this, particulars are given of the area, thickness, and composition of the filter-beds, and the condition of the water at the intakes.

Information respecting the chemical analysis of a water, one of the subjects "in addition," was first introduced into Colonel Bolton's monthly sheets in December, 1873. A special column, "Analysis of the Water," was then commenced, and was continued till December, 1874, when it ceased, and has not been revived. In the sheet for December, 1873, the analysis of the Kent, the New River, the East London, and the West Middlesex, were made by Dr. Letheby; that of the Lambeth was made by J. K. Bamber; while there was none made for the Southwark and Vauxhall, the Grand Junction, and the Chelsea. They are made "for the company." No reference was made in any way to explain why they were introduced, whether the companies thought that they thus showed how good their water was, or whether it was simply as a means of comparing results given in the returns to the Registrar-General is not explained.

The facts, taken as they stand, however, are as follows:—The waters of the companies had been analysed monthly, regularly for fourteen years, for the Registrar-General, when the "water examiner's" monthly sheets were commenced. Nothing on analysis was given in then, till the column referred to, "analysis of the water" made for the companies, was introduced. When this was given up in December, 1873, information respecting analysis was given on the back of the sheet; but it was something more than a mere change of position. The change began in the January sheet, 1875. The Water Examiner* then, for the first time, introduced a copy of the report made to the Registrar-General by Prof. Frankland. There is no title for the office held successively by Dr. Thomson, Prof. Hofmann, and Prof. Frankland, such as "Water Analyst." It would be convenient to have such a term, for though freedom from error in an analysis is not secured by its being "official," much stress is often laid in the controversies on London water supply, on the distinction between "official" reports and those made "for the companies." Prof. Frankland's first report in the sheet for May, 1874, on the Lambeth Company's water, is stated to have been made "for the company."† A question was raised in Parliament last Session as to whether certain monthly reports with an official looking title were official or not, and the reply was, that they were not. For want of some official title, such as "The Water Analyst," it often takes two or three lines of explanation to ensure accuracy of description in quoting reports. Colonel Bolton has endeavoured, in his monthly table, to give such information respecting the water as is likely to be of use, and, if there is no direct authority for printing reports of the analyses made "for the companies," it is in accordance with the spirit of Clause 36 of the Act of 1871, which provides that "the company may, if they think fit, on each occasion of such examination, be represented thereat by some officer, but such officer shall not interfere in the examination." There is a want of distinctness as to what is published by authority and what is not. The Acts, which are the sources of authority, are vague; the practice based on these Acts is variable. It is evident, that if the bare wording of the Acts only had been complied with, there

* In the margins of the appendices of the Local Government Board reports, the short titles given are: "Colonel Bolton's report," "Prof. Frankland's report," but they are indexed under their full title.

† Prof. Frankland states that he never analysed any water from the Lambeth Company, and that the figures given in Colonel Bolton's report of the water of this company, are the same as those of the analyses made officially for the Registrar-General in May, 1874; and published in the *Weekly Return*, for the week ending May 30, 1874.

would have been much less information available respecting London water supply than there is at present. On the other hand, for cases where it is important to distinguish between an official and unofficial report, it is difficult, if not impossible, to pick out what is included in a report, because it is useful, and what is included, because it is required to be there. For example, the report on the water supplied to Birmingham, and the water supplied to Glasgow, is sent in each month by Prof. Frankland to the Local Government Board. His own report of the analysis of the waters of the London companies is the official and only official report; but it is by no means clear how the reports for Birmingham and Glasgow stand.

This account of Colonel Bolton's series of reports does not attempt to decide what is official and what is not.

The change introduced in January, 1875, mentioned above, was accompanied by another change. By the side of the table, taken from analyses reported to the Registrar-General, in which the results are given in parts per 100,000, is a table in which the same facts are given expressed in "grains per gallon, for comparison with analyses furnished by water companies," and, under these, was given a table of the analyses made by Dr. Letheby on behalf of the companies. In February the same plan was followed, the only change of importance being that Prof. Frankland's analyses were addressed to the secretary of the Local Government Board, not to the Registrar-General. His table was on the same general plan as now, except that there was a column, "Previous Sewage or Animal Contamination, Estimated," which was discontinued after January, 1877. The three tables were continued in this way for nineteen months; but in September, 1876, Table No. 2 was discontinued, thus leaving the comparison of the parts per 100,000, and the grains per gallon of Table 3, to be worked out by those who cared to do so. Table 3 was continued by Dr. Letheby up to February, 1876. In March, 1876, and subsequently, this table was supplied by Dr. Meymott Tidy, but in June its title was changed to "Results of Analysis, made.....for the Society of Medical Officers of Health," and with this title, it was continued till December, 1879, when it disappeared. In the April of 1876, another change in form and another set of tables was introduced In the column, "appearance of water," which was first spaced out for the daily observations in February, 1876, and which hitherto had been devoted only to statements about clearness, there was introduced tables of analyses made "for the companies." The first was by Dr. Whitmore, for the West Middlesex Company. In the June sheet, at the end of paragraph 12, is this sentence: "The analyses furnished by water companies are given in the within report, under the head 'appearance of water.'" The exigencies of finding room for further information in the already crowded sheet was no doubt the reason for utilising the spaces in between the lines giving the statements as to appearance. It, however, makes the column contain not only two classes of observations—one physical and the other chemical—but two sets differing in their origin, one official and the other not. The statements as to clearness are the official reports of "the water examiner." These statements, indeed, constitute the report as required by Section 36 of the Act of 1871, while the analyses "furnished by the companies" are optional. With this re-introduction of the analyses "as furnished by the companies," there were at this time three series of analyses given in the report. 1. That reported officially to the Local Government Board. 2. Those made by Dr. M. Tidy for the Society of Medical Officers of Health; and 3. Those made by different analysts for the different companies. Series 2 was discontinued after December, 1880. The printing of the dates on which the samples were collected were given up to the end of 1879. In a paper read before the Chemical Society in December, 1878, Dr. Tidy wrote—"I was most anxious that Dr. Frankland and myself should examine samples taken at the same time, so that our results might be strictly comparable, and that this could not be arranged was no fault of Dr. Frankland's or of my own, as he himself expressed to me his desire and willingness to make the necessary arrangements, which, however, were interfered with. . ."* Though the dates on which samples had been taken never had coincided, they were given, and, as they were taken on one day in each month only, there was some rough guide. Coincident with the cessation of the dates, there was an entire change in the way of expressing the results obtained. Just before the cessation of Dr. Tidy's series there was introduced in the November sheet (the sheet for October) Messrs. Wanklyn and Cooper's series of reports.

Though, therefore, similar in appearance for so many years, the monthly sheets of the Water Examiner have varied much in the matter given "in addition to" the official report.

When Dr. Tidy's reports ceased those of Messrs. Wanklyn and Cooper took the second place, *i.e.*, immediately after Prof. Frankland's, and a totally new series was introduced in the third place, viz., the report by the Society of Public Analysts. The reports made the companies were the analyses of Drs. Tidy, Whitmore, or Bernays (the Grand Junction Company sometimes sending two reports). The reports of the Society of Public Analysts introduced a number of new names into the monthly sheet, but the report was given only in January and February, when the want of uniformity was severely criticised.

No further change took place till the introduction of the report by Messrs. Crookes, Odling, and Tidy.

(To be continued.)

CORRESPONDENCE.

RUBERINE.

To the Editor of the Chemical News.

SIR,—On referring to p. 100 of the Chemical Society's *Journal* for January, it will be found that the new colouring-matter ruberine, extracted from *Agaricus ruber*, is stated to be *insoluble* in water and in alcohol, whereas in my original note, published in the CHEMICAL NEWS, vol. xlvi., p. 199, I state that it is *soluble* in water and alcohol. In the "abstract," published by the Chemical Society's *Journal*, it is also stated that the solutions of ruberine are red by *reflection* and blue by *transmission*; whereas on reference to my original note in the CHEMICAL NEWS you will see it is *just the reverse*, the solutions being red by transmission and blue by reflected light.

Allow me to add that the American and Continental journals, which have reproduced my note from the pages of the CHEMICAL NEWS, have not fallen into such errors. Nor is this the first time that my attention has been called to similarly inaccurate "abstracts." I think it is the duty of any author to note inaccuracies of this description whenever he may observe them, as it saves a great deal of time and trouble to others, and points out the absolute necessity of referring to *original* papers in all matters relating to scientific observation.—I am, &c.,

T. L. PHIPSON.

London, January 7, 1883.

THE MANUFACTURE OF POTASH ALUM FROM FELSPAR.

To the Editor of the Chemical News.

SIR,—Amongst the notices from the *Journal of the Franklin Institute*, which you reproduce in the CHEMICAL NEWS, vol. xlvii., p. 5, is an article on "The Manufacture

* The conclusion of the sentence refers to official difficulties.

of Potash Alum from Felspar," by Mr. Henry Pemberton, Junr. In this the American writer gives a very fair summary of the difficulties to be overcome, and arrives at the conclusion that the cost of production will leave no margin of profit.

I am bound to say that with the accumulated experience which has come to my knowledge since reading the paper at the meeting of the Society of Chemical Industry, and hearing of the failure of the attempt to carry this process into practical operation at Conner's Quay, Flintshire, some years ago, by Mr. F. O. Ward, it does not appear that the process is likely to yield an advantageous result. The Messrs. Newlands stated in discussion at the meeting that they had proceeded much further than I did in preparing alum by this reaction on a large scale, but they did not think sufficiently well of it to warrant their risking a patent, finding, moreover, that Thomas Cobley had already a prior claim to the same idea (Specification No. 1734, July, 1861).

The "calcifluoric attack" of F. O. Ward may some day be practically utilised for the extraction of potash from granite and felspar, but it is clear, in view of these facts, that the time has not yet come for the successful development in England or America of the fundamental idea.—I am, &c.,

JOHN SPILLER.

London, January 9, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 2, 1882.

A Spectral Slit with a Symmetrical Movement of the Edges.—Dr. H. Kruss.—An improvement in the spectroscope for quantitative analytical purposes (German Patent, No. 7092). The arrangement cannot be intelligibly described without the three accompanying figures.

On the Certainty of the Method of Berthelot and Fleurien for Determining Tartar and Tar aric Acid.—Dr. C. Amthor.—The authors show that the method in question is quite untrustworthy, at least as far as red wines are concerned, as notable quantities of sulphuric acid are precipitated by the mixture of ether and alcohol and estimated as tartrates.

Contributions to the Analysis of Wine.—Dr. J. Nessler and Dr. M. Barth.—The results of the authors' experiments are given in the form of tables, and do not admit of abstraction.

Alkalinity of Potassium Mono-chromate, and the Real Colouring-Matter of Litmus.—M. Richter.

New Volumetric Determination of Potassium Bichromate and its Use for the Titration of Caustic Alkalies.—M. Richter.—See page 19.

Separation of Small Quantities of Nickel in Presence of Cobalt.—Dr. A. Jorissen.—Already inserted.

A New Reagent for Nitrous Acid.—Dr. A. Jorissen.—Already inserted.

Detection of Cuprous Oxide in Presence of Cupric Oxide and of other Metallic Oxides.—Anton Orlowski.—The liquid under examination is acidified with hydrochloric acid, a small quantity of pure milk of sulphur is added, and the whole is heated to a boil. A change of the pale yellow colour to a black shows the presence of cuprous oxide. If it is desired to detect cuprous oxide in liquids which undergo a change on boiling a piece of sulphur is thrown into the acidified liquid, and the whole is let stand for ten to twelve hours. In presence of much copper oxide the sulphur becomes blackened over its entire surface; if the quantity is small the sulphur turns brown on the sides only, or is covered with black spots.

Notes on the Determination of Phosphoric Acid.—Carl Mohr.—Already inserted.

Purification of Sulphuric Acid by Crystallisation.—R. S. Tjaden Moddermann.—The author finds that by repeated crystallisation a perfectly pure acid may be obtained from very impure samples containing lead sulphate, arsenious acid, and nitrogen compounds.

Reactions of Aloes.—Dr. W. Lenz.—An extensive memoir, chiefly of pharmaceutical interest.

Determination of the Foreign Elements contained in Work-Copper.—R. Fresenius.—See page 18.

Determination of Potassium as Potassium-Platinochloride.—R. Fresenius.—This paper will appear at length.

Determination of Glycerin in Sweet Wines.—Dr. Eugen Borgmann.—10 c.c. of wine are evaporated to dryness in a porcelain capsule along with some quartz sand. The syrupy residue is gradually extracted with a measured volume of absolute alcohol (100 to 150 c.c., according to the quantity of sugar present), and the extracts are collected in a roomy glass flask. To 1 part of the alcohol there is now added 1½ parts of ether, the whole is well shaken up, and let stand at rest till entirely clear. The greater part of the sugar will be found collected at the bottom as a syrupy mass, whilst all the glycerin is held in solution in the alcohol-ether. The liquid is carefully decanted off, the sediment is washed with a small quantity of a mixture of 1 part alcohol to 1½ part ether. The liquid and washings are then distilled, the residue is rinsed with a little water into a porcelain capsule, and treated according to Neubauer's method for dry wines.

General Analytical Methods, Analytical Operations, Apparatus, and Reagents.—W. Fresenius.—Spectroscopic notes have been made public by C. A. Young. In many cases by the application of a sufficient dispersion, he has succeeded in resolving lines supposed to be common to several elements into several lines peculiar to each element. The theoretical conclusions drawn by Lockyer and others from the assumed coincidence of the lines are thus deprived of their foundation. Improvements in the spectroscope have been devised by H. C. Vogel and K. Zenger, and described in the *Zeitschrift fur Instrumenten Kunde*. For weighing filters with precipitates C. Gilbert instead of watch-glasses uses a small hollow cone of nickelised copper foil. For determining the specific gravity of gases M. Th. Edelmann measures the pressure which columns of different gases of equal height exert upon a thin metallic membrane. Mercurial air-pumps have been devised by F. Neesen, E. Bessel-Hagen, and Alois Schuber, and are described in the *Annalen der Physik und Chem.*, vols. 11, 12, and 13. Capsules and funnels of papier-maché coated with a very resistant varnish are manufactured by R. W. Paulke, and are in many cases capable of being substituted for corresponding articles of glass, metal, or caoutchouc. The varnish resists undiluted sulphuric acid, strong alkalies, alcohol, ether, benzol, and carbon disulphide. A simple pipette for liquids which cannot be drawn up with the mouth has been devised by C. Mann. It consists of a moderately wide glass tube slightly contracted at one end, and its margin is expanded outwards at the other. This tube is thrust through the perforation of a cork in such a manner that the latter can slide up and down, though fitting air-tight to the tube. This cork is fixed air-tight in the lower end of a wider glass tube, which is either sealed above or closed with another cork. To use the pipette the wider tube is made to slide down as far as possible upon the narrower tube, the contracted end of the

latter is placed in the liquid, and the wider tube is then pushed upwards. This effects a rarefaction of the air within, and thus causes the liquid to ascend in the narrower tube. It can be expelled again by sliding the wider tube down. Caoutchouc tubes, according to Mareck, may be preserved from spoiling by keeping them under water when not in use. Caoutchouc stoppers which have become hard may have their pliability restored by digestion ten days at 40° to 50° in a 5 per cent solution of soda which is frequently renewed. They are then washed with water, scraped with a knife, washed again with warm water, and are fit for use. A new eudiometer has been proposed by J. Riban. Its construction cannot be intelligibly described without the illustration.

Chemical Analysis of Inorganic Bodies.—E. Hintz.

Qualitative Determination of Organic Bodies.—W. Fresenius.—Notices are given on the spectra of carbon and its compounds, by Messrs. G. D. Liveing, Dewar, Lockyer, A. S. Herschel, and W. M. Watts, as taken from the *Proceedings of the Royal Society*, *Nature*, &c.

Detection of Water in Alcohol and Ether.—C. Mann.—Already noticed.

Elementary Analysis of Organic Bodies.

Detection of Nitrogen.—O. Jacobsen.—From the *Berichte der Deutsch. Chem. Gesellschaft.*

Determination of the Carbon and Hydrogen in Nitrogenous Bodies.—W. H. Perkin.—From the *Journal of the Chemical Society*.

Determination of Nitrogen in Organic Matter.—S. W. Johnson and E. H. Jenkins.—This paper requires the accompanying illustration.

Analysis of Milk.—Notices of the methods of Hager for determining the total solids, the caseine, and the lactose; and that of C. Arnold for estimating the dry matter. D. Fuchs notices that pure milk never contains nitric acid, which is generally present in samples let down with water. Soxhlet defends his areometric process for the determination of the fatty matter against the criticism of Preusse. O. Dietzsch proposes a modification of the lacto-butyrometer. Heeren's "pioscope" serves to judge the quality of milk by the colour of a thin stratum, as seen through black glass. To distinguish boiled milk from fresh, C. Arnold adds tincture of guaiacum: fresh milk shows a persistent blue colour, whilst such as has been heated above 80° remains colourless. For the quantitative determination of dust in the air, W. Hesse aspirates a known volume through a small glass tube filled with cotton-wool.

Determination of Phosphoric Acid in Manurial Agents.—This extensive paper will be given at length at the earliest opportunity.

A Simplified Method of Determining Cellulose in Cattle Foods, &c.—This memoir requires the accompanying illustration.

Determination of the Value of Commercial Potassium Iodide.—O. Kaspar.—The author's method depends on the circumstance that 4 mols. potassium iodide are decomposed by 1 mol. mercuric chloride, so that along with potassium chloride there is formed a soluble double salt. If an excess of mercuric chloride is added this double salt is decomposed, and mercuric iodide is deposited, the commencement of which indicates the end of the reaction. To make the mercuric solution 2·71 grms. sublimate are dissolved in water, and made up to 100 c.c.; 1 c.c. of this solution indicates 0·06643 grm. potassium iodide. To effect the determination, a solution is prepared containing 10 grms. potassium iodide in 50 c.c., and 5 c.c. are used for each titration. The liquid is placed in a beaker, and the mercuric solution dropped in till a permanent reddish yellow colour appears. The mercuric solution should be freshly prepared for every series of experiments.

MISCELLANEOUS.

Royal Institution.—Professor W. C. Williamson will begin a course of five lectures on "The Primæval Ancestors of Existing Vegetation, and their Bearing on the Doctrine of Evolution," on Tuesday next, January 16. Professor Dewar will begin a course of nine lectures on "The Spectroscope and its Applications," on Thursday, January 18. Mr. R. Bosworth Smith, at the Friday evening meeting, January 19, will give a discourse on "The Early Life of Lord Lawrence in India"; and will begin a course of four lectures on "Episodes in the Life of Lord Lawrence," on Saturday, January 20.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 15.—London Institution, 5.
— Medical, 8.30.
TUESDAY, 16th.—Royal Institution, 3. "Primæval Ancestors of Existing Vegetation," by Professor W. C. Williamson.
— Institution of Civil Engineers, 8.
— Pathological, 8.30.
WEDNESDAY, 17th.—Society of Arts, 8. "The Sanitary Inspection of Houses," by W. K. Burton,
— Meteorological, 7. (Anniversary.)
THURSDAY, 18th.—Chemical, 8. "On a New Method of Estimating the Halogens in Volatile Organic Compounds," by R. P. Plimpton, Ph.D., and E. E. Graves.
— London Institution, 7.
— Royal, 4.30.
— Philosophical Club, 6.30.
— Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
FRIDAY, 19th.—Royal Institution, 9. "Early Life of Lord Lawrence in India," by Mr. R. Bosworth Smith.
SATURDAY, 20th.—Royal Institution, 3. "John Lawrence at Delhi and its Neighbourhood," by Mr. R. Bosworth Smith.

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HOUR, THREE O'CLOCK.

Professor W. C. WILLIAMSON, F.R.S.—Five Lectures on the Primæval Ancestors of Existing Vegetation, and their Bearing upon the Doctrine of Evolution; on Tuesdays, Jan. 16, 23, 30, and Feb. 6, 13. *Half-a-Guinea.*

Professor DEWAR, F.R.S.—Nine Lectures on The Spectroscope and its Applications; on Thursdays, Jan. 18 to March 15. *One Guinea.*

R. BOSWORTH SMITH, Esq., M.A.—Four Lectures on Episodes in the Life of Lord Lawrence; on Saturdays, Jan. 20, 27, and Feb. 3, 10. *Half-a-Guinea.*

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First Friday Evening Meeting, 8 p.m. R. BOSWORTH SMITH, Esq., M.A., on The Early Life of Lord Lawrence in India, 9 p.m.

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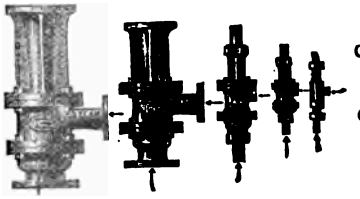

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1208.

EXPERIMENTS, BY THE METHOD OF LORENTZ, FOR THE FURTHER DETERMINATION OF THE ABSOLUTE VALUE OF THE BRITISH ASSOCIATION UNIT OF RESISTANCE,

WITH AN APPENDIX ON THE

DETERMINATION OF THE PITCH OF A STANDARD TUNING-FORK.*

By Lord RAYLEIGH, F.R.S.,
Professor of Experimental Physics in the University of Cambridge,
and Mrs. H. SIDGWICK.

The experiments described in the present paper were carried out during the spring and summer months of the present year, at the Cavendish Laboratory, and are divided into three distinct series. In the first and second series the induction coils were situated nearly in the plane of the revolving disk, as in Lorentz's original use of the method; the difference between the two series relating only to the speed of rotation, which was varied in the proportion of 10:16. The third series presents a point of novelty, in that the induction-coils were separated from the disk to such a distance as to render the accuracy of the result practically independent of the mean radius of the coils.

The small resistance traversed by the battery current, to which the terminals of the galvanometer branch are connected, was obtained, indirectly, by a method of shunting. Thus, in the first series, the principal part of the battery current passed on one side through two unit coils, placed in multiple arc, and equivalent to $\frac{1}{2}$, and only a comparatively small remainder through a second branch, composed of two coils, of values 10 and $\frac{1}{10}$. The terminals of the galvanometer branch were connected with the extremities of the $\frac{1}{10}$, and the difference of potentials between them, due to the primary current, was thus reduced to that which would be required to drive the current through a resistance of $\frac{1}{200}$.

From the first series—

1 B.A. unit = $0{\cdot}98674 \times 10^9$ C.G.S.

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As a mean we take—

1 B.A. unit = $0{\cdot}98677 \times 10^9$ C.G.S.

With use of the ratio between the mercury unit and the B.A. unit, found by us (*Proc. Roy. Soc.*, May, 1882) this gives—

1 mercury unit = $0{\cdot}94150 \times 10^9$ C.G.S.,

or, which is the same thing, the ohm is the resistance of a column of mercury at 0° Cent., whose section is one square millimetre, and whose length is—

1062·14 millimetres.

The very close accordance between the result of the present investigation and that obtained by the method of the revolving coil (0·98651), and by Glazebrook (0·98665) using another method again, leads us to hope that no error of importance can have escaped detection.

The Appendix is devoted to a record of experiments having for object the determination of the absolute pitch of a certain tuning-fork, which has served as the standard of time throughout all our work upon this subject. It is believed that the method employed is worthy of attention, and may be useful to other physicists.

* Abstract of a Paper read before the Royal Society, Jan. 11, 1883.

PRELIMINARY NOTICE OF THE ACTION OF DIBROM-NAPHTHOL UPON AMINES.

By RAPHAEL MELDOLA.

The dibrom naphthol (m.p. 111°), obtained by brominating *α* naphthol, acts as a powerful oxidiser when heated with certain amines. Thus, when kept in a state of fusion for some time in the presence of diphenylamine, diphenylamine blue is formed in large quantity; and similarly the condensation-product of benzaldehyd and diphenylamine (diphenyl-diamido-triphenyl-methane) is instantly converted, by warming with this substance, into the diphenylamine green, described by me in a former paper under the name of "Viridine" (*Journ. Chem. Soc.*, May, 1882). When dibrom-*α*-naphthol is dissolved in aniline and the solution heated to 140° C. for about thirty minutes, a fine orange colour is developed, and on diluting with alcohol a basic substance, crystallising in large orange needles, separates out. Similar bases are obtained from para-toluidine and *β*-naphthylamine. These bases dissolve in hot dilute acids with a fine crimson colour, and form well characterised salts; the double salts with $PtCl_4$, $ZnCl_2$, &c., are bronzy crystalline products.

Other colour reactions of dibrom-naphthol and other haloid derivatives of phenols have been tried in the course of the present research. Thus dibrom-naphthol gives with *α*-naphthylamine and with cumidine, colours dissolving in alcohol with a magenta-like red; with resorcinol it gives a reddish brown. Monobrom-*β*-naphthol heated with *α*-naphthylamine gives a fine red. Tetrabrom-*β*-naphthol readily gives diphenylamine blue, and with *β*-naphthylamine a dull violet. Finally, tribrom-phenol oxidises diphenylamine into the well-known blue; with *α*-naphthylamine this compound gives a red, and with *β*-naphthylamine a violet.

The basic substances resulting from the action of dibrom-*α*-naphthol upon aniline, para-toluidine, *β*-naphthylamine, and other primary aromatic monamines, have for some months past been under investigation, and I hope shortly to be in a position to give more complete details as to their chemical structure. They appear to be produced by the replacement of both bromine atoms by substituted amido-groups.

In the mean time, I may state that an abstract of a patent by Leopold Casella and Co. (3rd addition to the German Patent, No. 15,915), for the preparation of blue and violet colouring-matters by the action of dibrom-*α*-naphthol upon para-diamines, which appears in No. 18 of the *Berichte*, just received, has determined the publication of this note in the present imperfect state of my investigations.

Atlas Works, Hackney Wick, E.,
January 11, 1883.

RESEARCHES ON THE GROWTH OF PLANTS UNDER SPECIAL CONDITIONS.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts,
Medallist in Chemistry and Botany, &c.

Having heard of the remarkable properties of a certain patent chemical manure,* which has been known in the market for several years, in aiding the growth of plants,

* Manufactured by Amies' Chemical Manure Company, London; and in use, I believe, in the Gardens of the Royal Botanical Society, and the Horticultural Society.

the author tried a few experiments a short time ago, to ascertain, if possible, the reason why plant life when treated with this particular manure should grow so luxuriantly as was evident from the condition of certain vegetables, fruits, and flowers belonging to some friends who used it. The manure is a dry black powder, and its chief ingredients are animal charcoal, phosphates, and ferrous sulphate. The details of the experiments are as follows:—

Three very young savoy cabbages, all nearly of the same weight, and in a healthy condition, were chosen. No. I. cabbage was planted on a piece of land, and no manure was added to the soil in which it grew. No. II. cabbage was planted on the same piece of land and near to No. I., but was treated with a weighed quantity of this chemical manure. No. III. cabbage was planted on a different piece of land to that on which Nos. I. and II. stood, and was treated like No. II. with the same quantity of manure, but grew more in the shade.

Plants Nos. I. and II. therefore received the same amount of sunlight and rainfall, but No. III. plant grew under different conditions. All the plants were placed in the ground on the same day, and grew from February to December. Then they were carefully taken up with their roots attached, all adhering soil was removed by washing, and they were then weighed.

Plant No. I., grown without the manure, weighed 4 lbs. 2½ ozs.

Plant No. II., grown with the aid of the manure, reached the great weight of 9 lbs. 3 ozs.

Plant No. III., also treated with the manure, but under different circumstances to those of No. II., weighed 8 lbs. 6 ozs.

These were grown in a garden in the vicinity of Lower Norwood, Surrey.

Now, various parts of the leaves and of the stem of each plant were separately reduced to ashes, the greatest care being taken in the incineration, to prevent the alkaline salts fusing, &c. The plants were burnt on a platinum sheet made in the shape of a muffle, and heated at a low temperature in a gas-furnace. These ashes gave the following results on being submitted to chemical analyses:—

	No. I.		No. II.		No. III.	
	Leaves.	Stalk.	Leaves.	Stalk.	Leaves.	Stalk.
Potash	33·951	41·231	31 634	39·223	31·521	38·929
Lime	15·665	13·601	14·210	13 583	14·310	13·621
Soda..	2·523	4·296	1·825	2·360	1·917	1·813
Iron (Fe_2O_3)—	8·323	1·502	12·290	3·521	11 832	3·005
Magnesia	4·936	6 210	3·128	6·000	2·921	5·942
Phosphoric Acid—	12·931	14·463	16·210	18·944	16·123	18·891
Sulphuric acid—	8·613	9·619	7·641	8·916	7·592	8·922
Chlorine—	7·994	6·781	7·310	4·200	7·400	4·319
Silica	4·999	2·294	5·631	3·121	6 265	4·468
	99·935	99·997	99 879	99·868	99·881	99·910

It will be seen from the above analyses that the plants treated with the manure contain a larger proportion of iron than those grown without the manure, and the leaves contain a larger percentage of iron than the stalks.

The conclusions to be drawn from these experiments are:—

1st.—The plants when grown in soil containing iron in a soluble form, and with phosphoric acid also in a soluble form, are healthier and larger than if they had been grown in a soil which did not contain these soluble compounds.

2nd.—The plants grown in soils containing this mineral manure appear to absorb larger quantities of soluble iron and soluble phosphates than when not so treated.

3rd.—The plant No. II., which was placed in the most favourable position as regards sunshine and rain, absorbed a greater amount of soluble iron and soluble phosphoric acid than plant No. III., which was grown in a less favourable position. Whether the plants have the power of selecting and taking up by their rootlets these compounds from the manured soil, or whether the plants simply absorb any substance in solution supplied to them, I am unable to say; but it appears that the healthy condition and gigantic growth of the plants Nos. II. and III. were due to the fact that they were supplied with iron (in a soluble form, $FeSO_4$) and phosphoric acid also in a soluble form.

I am inclined to think that a fairly large proportion of soluble iron and soluble phosphates in a soil is favourable to the growth of plants of a deep green colour (that is, plants which develop a large amount of chlorophyll cells), like the varieties of cabbage.

From the researches conducted by Mr. F. C. Phillips, of the United States, "On the Absorption of Metallic Oxides by Plants" (CHEMICAL NEWS, vol. xlvi., p. 224), it seems that his experiments confirm the non-discriminating theory of plant absorption of Dr. Freytag.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from p. 4.)

IX. Boric Acid and Aluminium Plate (*Continued*).

A. *The Inner Balls or Sphericles of Calcium Borate.*

It is a well-known fact now to most English, German, and American Chemists, not behind the progress of the day, that calcium pyroborate consists of 25 parts of caustic lime, and 75 of pure boric acid; or that, in other words, if you apply a weighed quantity of freshly-calcined lime to pure boric acid at blowpipe temperature, you will obtain a product—an insoluble transparent mass (fused boric acid itself being *extremely* soluble in boiling water) hard enough to scratch glass—exactly four times the weight of the caustic lime used to make it. This fact alone, the importance of which will be seen presently, ought, at last, to convince our chemists that these methods of blowpipe analysis are based upon sound chemistry, whilst the indefinite borax, or S.Ph. crystallisations are as evidently not, and lead to nothing but wasted time and talents in their examination, with the inevitable "vexation of spirit" accompanying such a loss. Twelve others of the "elementary" oxides thus form balls or sphericles when applied to boric acid B.B., which products are as evidently borates of those metals as calcium borate is of calcium, whilst some (as that of nickel), which form only fragments in this way, are obviously borates too, for, under adequate microscopical power, they are seen to consist of *definite* crystals.

It is not, however, with regard to this matter that I wish now to ask the attention of your chemist readers and your own, but to one comparatively new, which, for me, at least, possesses the most intense interest. About two years ago, by the advice of Dr. Edmunds, of Grafton Street, I invested in a first-class microscrope for the purpose of examining the contents of these boric beads, and naturally, first submitted to the revealing powers of my new friend, a bead containing *wollastonite* borates, which had long puzzled me, using only a lens, on account of the curious "crystalline marks"* covering the calcium borate balls; evidently due to the silica contained in that mineral. A ¼-inch objective at once showed me that these "marks" were transparent *inner balls*, due in some way or other to the silica of this calcium silicate (*wollastonite*); and it seemed to me, therefore, that, as to composition, the inner balls must be either silico-borate of calcium, or single borates, *i.e.*, silicon borate; which latter compound seemed

* "Alphabetical Manual of Blowpipe Analysis," page 118.

a chemical paradox. As the containing calcium borate ball is utterly insoluble in boiling water, and I at present know no menstruum* which will dissolve the outer, and leave entire the inner balls, so as to enable me to examine them *per se*, I was compelled to employ a process of mental ratiocination, instead of a process of physical analysis, to effect my object. I argued thus: "If these inner balls are silico-borate of calcium, balls will be formed when pure silica is applied to the calcium borate, held *by itself*, on a platinum wire without the containing bead of boric acid before the blowpipe: if, on the contrary, fresh boric acid derived from the outer containing bead is absolutely necessary for their formation, the presumption must be that the calcium borate will not give up any part of its proportion of boric acid to make the inner balls, so that that component must be *passed on*, as it were, from the outer containing *bead*, through the calcium borate *ball*, to the silica inside, and thus form *inner* balls of silicon borate." I trust I have expressed myself clearly in this account, and that the inference I have drawn from what happened is, in the opinion of your readers, a just one. If not, I would respectfully ask from yourself or your readers, the suggestion of another alternative.

However paradoxical it may appear, the latter was the alternative afforded me by the practical experiment. Pure silica dissolved rapidly, transparently, and completely in calcium borate before the blowpipe, affording no balls; but, on crushing this siliceous calcium borate, and applying some of the powder to a fresh bead of boric acid B.B, balls were formed in the bead perfectly crowded with *inner* balls. Another extremely interesting fact was ascertained with regard to the *change of weight* of these siliceous calcium borate balls, which I must leave to be considered in another paper.

B. *Black Sublimates from Volatile Metals on Aluminium Plate.*

I believe I was the first to discover (in 1871) the curious fact that volatile metals evolve a *black* sublimate when treated before a blowpipe (in addition to their other sublimates), which has been lost to pyrological chemists, on account of their use of black charcoal as a support. This black sublimate invariably occupies the lowest position on the vertical aluminium, surrounding the assay itself, and, as can easily be proved by means of boric acid, and in other ways, is in a state of lower oxidation than any other sublimate.

Surely, it is a most extraordinary, and extraordinarily interesting fact, that these "semi-metals" of the old chemists and alchemists, should *invariably*—however different the colour and form of their other sublimates may be—afford this black suboxide or body-sublimate when thus treated? It is a *constant* product in the sublimation of *all* these metals, each black part being almost or exactly similar to the other black part, until changed by pyroxidation or other means; and therefore would seem to be a constant factor or constituent in all of them. No doubt all metallic sublimates can now be very much more easily, and, therefore, closely, examined than the old sublimates, scraped from what was left of them after blowpipe treatment on charcoal, could possibly have been. For instance, the late Professor Plattner very naturally considered, as the white sublimate from lead was produced by the blowpipe *on charcoal*, and as the known chemical oxides of lead (also produced by the blowpipe), are differently coloured,—yellow, red, brown, &c.,—whilst the known chemical carbonate of lead is white, that the white sublimate evolved from pure lead on charcoal by the blowpipe is "carbonate of lead"; but if he had used aluminium plate and boric acid in his examination of this matter, he would have found (*a*) that the white sublimate from pure lead, carefully scraped off aluminium plate, dissolves transparently and without effervescence, in boric acid before the blowpipe; and (*b*) that an indubitable carbonate of lead (such as *cerussite*) when similarly treated, immediately renders the bead milk-white and opaque, much effervescence (carbon dioxide) being at the same time produced.

(To be continued.)

* Prof. G. G. Stokes recommends me to try acetic acid.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending December 31st, 1882.

By WILLIAM CROOKES, F.R.S.
WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;
and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Right Honourable the President of the Local Government Board.

January 1st, 1883.

Sir,—We submit herewith the results of our analyses of the 161 samples of water collected by us during the month of December, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 161 samples, the whole, without a single exception, were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of a daily sample, taken from December 1st to December 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen that in respect of aëration, colour, and freedom from turbidity, the condition of the water during the past month has been unexceptionable; while the proportion of organic matter has fallen somewhat below that usually met with at this period of the year.

In our own previous monthly report we drew attention to the circumstance that, concurrently with the setting in of the winter season, there was, as there customarily is, a notable increase in the proportion of organic matter present in the water supply. In the report for the same period made to the Registrar-General, attention was also called to this increase; and further, the water distributed by four out of five of the Companies taking their supply from the Thames, was pronounced *ex cathedrâ* to be "unfit for drinking" by reason of its "organic impurity." Now we take upon ourselves to assert that the analytical results set forth in the report, which are not appreciably different from our own, do not afford ground for any such appalling statement; and that the million or more consumers of the water furnished by these stigmatised companies, have not had their health in any way jeopardised by their consumption of the water supplied to them; and that they have not been placed, during the month of November, in any respect in a different position, as regards injury to health, consequent on the character of their drinking-water—admittedly unobjectionable in taste and appearance—from that in which they were placed during the summer months; when, owing to the different conditions of river life and change, the proportion of organic matter in the water was about one-third or one-fourth of its recent amount,—the maximum of which found in any sample, as recorded in the report to

the Registrar-General, was under three-quarters of a grain per gallon, or amounted to about the one-thousandth part of one per cent of the reprobated water.

As bearing on this question, we would recall to mind that the last Royal Commission on Water Supply, after hearing very varied scientific evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial, and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial.

We have the honour to remain, Sir,
Your obedient Servants,

William Crookes,
William Odling,
C. Meymott Tidy.

CHEMICAL ANALYSIS OF INORGANIC BODIES.

By E. HINTZ.

A. Classen and M. A. von Reiss propose for the separation of metals, the electrolysis of the double compounds of the oxalates and ammonium oxalate. Simultaneously and independently, H. Reinhardt and R. Ihle propose to determine zinc by the electrolysis of the potassium double oxalate. (For a description of the processes of Classen and Von Reiss see Chemical News, vol. xlvi., p. 105.)

Reinhardt and Ihle prefer to separate zinc from the potassium double salt, because, according to their experiments, this metal is apt to deposit in a pulverulent form if ammonia or nitrates are present. The determination is not interfered with by the presence of free oxalic acid, though the precipitation is rendered slow. A current which yields 90 c.c. detonating gas hourly is sufficient for the complete precipitation of zinc. On account of the ease with which precipitated zinc is oxidised, the authors recommend that it should be dried in the exsiccator.

For the determination of cadmium E. F. Smith recommends the electrolysis of the neutral acetate. Cadmium can also be perfectly separated from a hydrochloric, nitric, or sulphuric solution after supersaturation with sodium acetate. In opposition to the statement of Wrightson, that the sulphate is not well suited for the electrolytic determination of cadmium, he has obtained satisfactory results with the neutral sulphate, and even in presence of free sulphuric acid.

The circumstance that cadmium is not precipitated by the current from solutions containing free nitric acid has been applied by Smith for the separation of cadmium from copper. After precipitating the copper he draws off the liquid, concentrates, adds excess of potassa and potassium cyanide, and submits to electrolysis.

For the determination of uranium and its separation from the alkalies and alkaline earths, E. F. Smith proposes the following method:—

The solution of the acetates, slightly acidified, is introduced into a platinum capsule, which serves as positive electrode. If the capsule is heated in the water-bath and submitted to the current of two chromic acid elements, yellow uranium hydroxide is first deposited on the sides of the capsule, which gradually becomes black, passing into urano-uranic hydroxide. When this change has taken place no more uranium can be found in the solution. The liquid is decanted out through a small filter, and the capsule is washed with hot water. To determine the precipitate the filter is replaced in the platinum vessel, dried, incinerated, ignited, and weighed as uranoso-uranic oxide.

E. F. Smith has extended his experiments to molybdenum. From an ammoniacal solution of molybdic acid the molybdenum may be completely thrown down electrolytically as hydrated sesquioxide, but the precipitation requires so much time that the method cannot be recommended.

Smith's method of separating barium from strontium, calcium, and magnesium was to precipitate the barium from a neutral solution with neutral potassium chromate. Frerichs modifies this process by precipitating the barium in an acetic solution. Morse considers the precipitation in an acetic solution as approximately complete, but the washing with dilute acetic acid he finds inadmissible unless some barium chromate is added, when the quantity of barium chromate dissolved is vanishingly small.

For the separation of iron from manganese, zinc, cobalt, and nickel, J. Jewett mixes the cold concentrated acid solution with sodium carbonate until a slight precipitate is formed, which is not re-dissolved on shaking. This precipitate is dissolved in hydrochloric acid added by drops, carefully avoiding excess. He adds a certain quantity of acetic acid, to be found in a table which he appends, and sodium acetate, and boils for a minute or two minutes, after diluting the solution to about 300 c.c. The precipitate is then washed with boiling water containing 2 grms. per litre sodium acetate and 1 c.c. acetic acid till the chlorine reaction disappears. If the proportion of acetic acid exceeds 5 per cent, iron remains in solution.

For the separation and volumetric determination of lead, Haswell proposes a method based on the following reaction:—If a moderately dilute solution of lead nitrate is mixed with a few drops of very dilute pure potassa, gently heated, and a solution of potassium permanganate added, the latter liquid is decolourised with formation of a deep brown precipitate, so long as the solution contains lead. The process is executed as follows:—The solution containing the lead as nitrate, and which may be neutral or slightly acid, is mixed with zinc oxide suspended in water, and a solution of permanganate of known strength is dropped in, in the cold, with constant agitation, until the liquid floating above the precipitate has a faint pink tint. On applying heat, this colour disappears. The reaction cannot be considered complete until the faint pink colour produced on adding another drop of permanganate does not disappear on boiling for a minute. Alkalies, alkaline earths, and salts of alumina, chrome, zinc, and iron (ferric), do not interfere. The method is not admissible in the presence of salts of manganese, cobalt, nickel, iron (ferrous), bismuth, and copper. Traces of silver are not injurious.

Hydrobromic acid is recommended by Endemann and Prochazka as a sensitive reagent for copper. A solution of copper bromide on evaporation, or treatment with dehydrating agents, appears, first, deep red-brown, and then black. If the cupreous liquid to be tested is mixed with an excess of concentrated hydrobromic acid, the change of colour begins at once. According to the author 1-100th m.grm. copper occasions a rose colouration. The presence of great quantities of iron interferes with the reaction.

The process of Schneider and Fyfe for the separation and determination of arsenic as modified by Emil Fischer has been already noticed.

M. Richter proposes to determine chromic acid when occurring in neutral alkaline chromates, volumetrically, by precipitating completely with a solution of silver nitrate of known strength, and determining the excess of silver nitrate with sodium chloride.

For the detection of chloro-chromic acid, H. W. Wiley places a drop of sulphuric acid in a porcelain capsule, adds a little strychnine, and stirs with a glass rod, which has been previously moistened with a liquid containing chloro-chromic acid. The well-known violet-blue colouration appears which characterises strychnine when its sulphuric solution is treated with an oxidising agent.—*Zeitschrift fur Analytische Chemie.*

Appointment.—Mr. F. J. M. Page, B.Sc., F.C.S., of University College, London, was elected, on January 11, Lecturer on Physics at the London Hospital Medical College.

USE OF CŒRULEINE IN WOOL-DYEING.

By AMAURY DE MONTLAUR.

WHEN M. Durand made his interesting communication to the Society of Mulhouse this dye was too costly to be of practical importance. Its price has now been reduced to 3½ francs per kilo., and a kilo. of wool may now be dyed for 1 franc, which is not more than the general cost of fast colours. Contrary to what has been said, the only good method of applying this colour is by reduction and subsequent oxidation.

For wool-dyeing the colour is stirred up in a pail with an equal weight of sodium bisulphite (sp. gr. 1·39); zinc powder is added to the extent of one-tenth of the weight of the cœruleine. The whole is intimately mixed, the pail is covered up, and let stand for two hours. It is then added to the dye-pan and the temperature is raised.

The wool should be mordanted with alum or sulphate of alumina and cream of tartar, as for madder. In this manner good greens are obtained with perhaps a slight olive cast, but soaping at a hand-heat brightens the shade.

Chrome mordants are much superior for the intensity and fineness of the shade. I have remarked that many dyers do not neutralise their alums. Alum is sometimes used which requires 8 per cent of its weight of soda crystals for neutralisation. Hence the formation of insoluble salts becomes very problematical, and to fix the mordant in the fibre violent and prolonged boiling is required, which weakens the wool, felts it, and occasions waste, in addition to yielding tissues of a less silky handle. This procedure renders the dyeing more tedious, and the prolonged boiling in the case of cœruleine re-oxidises the bath and necessitates the addition of bisulphite, a fresh cause of expense and of uncertainty as to the reducing value of the bath,—a very important point in cloth-dyeing. The wool is introduced into the bath, which ought to have a brown colour, slightly yellowish, and is well worked. If the bath is green, and if the wool takes a green tint in the bath, more bisulphite must be added mixed with the tenth part of its weight of zinc powder. The wool is kept at a gentle boil, and it is well to cover the pan with boards to exclude air as much as possible. The dyeing is carried on till a bit of the wool, well drained and exposed to the air for ten minutes, takes the required shade. The wool is then taken out, well drained as it issues from the liquid, and spread out in a thin layer to promote oxidation. It is turned over several times at intervals of some hours, so that every part may be equally exposed to the air. At the end of twelve to fifteen hours it may be washed, but it is better to allow it first to dry.

Cloth-Dyeing.—For very compact goods, such as army cloths, cœruleine is not to be recommended. Light goods are easily dyed, but a much larger quantity of the reduced dye is needed than for wool. The cloth when taken out of the dye-pan should be drained rapidly and completely, otherwise there is danger of spots, especially if an excess of bisulphite has been employed.—*Moniteur Scientifique.*

Methods relating to Forensic Chemistry.—W. Lenz.—A. G. Pouchet proposes to effect the destruction of organic matter prior to the search for mineral poisons by treatment with 25 per cent pure potassium bisulphate and the same weight of fuming nitric acid. Selmi makes up the matter to a paste with sulphuric acid, and treats it with a current of hydrochloric gas at 130°; the gas passes out through a receiver heated to 130°, and is then received in water. F. Selmi finds in the urine of persons poisoned with arsenic, not merely arsenious acid, but also arseniferous bases. Hager notes that Schneidor's method for the separation of arsenic by distillation as chloride can be effected even if the arsenic is present in the state of arsenic acid. E. Reichhardt gives a modification of Lassaigne's process, which cannot be reproduced without the accompanying figure.—*Zeitsch. f. Anal. Chem.*

REPORTS ON THE EXAMINATION OF THAMES WATER.*

(Concluded from p. 23).

Registrar-General's Report.

IN the weekly return of the Registrar-General for October, 1857, p. 334, there is given an analysis of the water of the Southwark Company, by Dr. Robert Dundas Thomson, of St. Thomas's Hospital. This appears to be the first time that water analysis found a place in these publications. Dr. Thomson, in November, first supplied the analyses of the waters of the various companies, and his reports for November and December are given in the first number (for January), 1858; from that time he continued to furnish monthly reports till June, 1864. It would be interesting to know the history of thought on the subject of water in connection with health, at the period of 1850 to 1860. In the "Notes on Previous Enquiries," there was brought together as much as could be found of printed opinions, and of records of the investigations made to estimate the truth of the supposition that disease might be spread by water; a supposition arising with, or at least brought forward by, Dr. Snow. But beyond these records, except, perhaps, in the daily press, there is no indication that the subject did receive much thought. The inquiry into the 1849 outbreak of cholera probably drew attention first to the subject, and in the writings of Simon and Farr will be found probably all that is of lasting value. But the inquiries were of a purely statistical character, the chemical examination of the water was not included. That whatever had any influence at all in connection with disease was an idea pronounced, in eloquent language, as preposterous, and was evidently only timidly and cautiously admitted by those that did admit it. The inquiries of 1851 and 1856, however, were specially directed to chemical subjects, and instructions as to the points on which information was wished were issued. By 1857, the chemical analysis of a company's water found a place, as mentioned in the Registrar-General's Report. From 1858, "monthly analyses," that is, monthly returns, stating the results of analyses of water, taken one day in each month from a company's supply, have been issued, except for the months from July, 1864, to January, 1865. Dr. Thomson supplied them gratuitously at first, but after January, 1862, the Treasury allowed a small annual payment for them. They may be regarded, therefore, as official from this date. The gap from July, 1864, to February, 1865, was caused by Dr. Thomson's death.

The analyses for February, March, April, and May, 1865, were made by Prof. Hofmann, and that of June by Prof. Frankland, who has regularly furnished the monthly analyses since. The place in which this series of monthly reports is issued is the "Weekly Returns of Births and Deaths in London." The report for a month is generally given in the number for the second or third week of the succeeding month. It has sometimes been later, and as there is no index, there is no other course for those who wish to consult a series in any period, than to look through the weekly returns. In almost all cases, in addition to the mere table of figures, there is a more or less extended report, whilst occasionally, as during the prevalence of a cholera epidemic, special and elaborate reports have been given (see Registrar-General's Weekly Returns for 1866, p. 451); but to these, again, there is no index.

In the 1866 Rep., supp., p. 257, app., is a summary and comparison of 1850, 1856, and 1866.

Besides the weekly returns, there is an annual publication of the Registrar-General, in which, since 1867, Prof. Frankland has made a formal "Report on the Analysis of the Waters."† The first was a report of three pages, with

* From the *Journal of the Society of Arts.*

† The Annual Reports of Professor Frankland were not brought under notice in the article printed in the *Journal of the Society of Arts* of September 8. The monthly reports only are mentioned at p. 673.

five pages of tables. (In the previous year there was a letter of half a page). This annual publication is quite distinct from the annual report of the Registrar-General. It is a summary of the weekly returns during the year; it was not, however, called a summary on its title page, till 1866, and it was not until 1870 that the title-page bore "Annual Summary." It is now commonly quoted as the annual summary of the Registrar-General. In everything but the title, however, it is practically the same sort of publication as it was in 1860, when the title was "Weekly Tables of Births, Deaths, and Causes of Death, in London, during the year." To those not acquainted with these changes, there might appear to be two distinct series.

The Object of the Tables.

The explanation of what the tables given in the reports mean, and what is supposed to be the value of the determinations, must be sought principally in papers read before the Chemical Society. The most important of these papers are:—Prof. W. A. Miller, in vol. xviii., 1865; Prof. Frankland, in vol. xix., 1866; Prof. Wanklyn with Messrs. Chapman and Smith; and another by Prof. Wanklyn, in vol. xx., 1867. Then in the next year, 1868, vol. xxi., four papers, by Prof. Frankland and Mr. Armstrong, by Prof. Frankland, by Prof. Wanklyn and Messrs. Chapman and Smith; by Mr. Chapman;* in vol. xxix., 1876, by Prof. Frankland; in volume for 1878, by Dr. Mills; in volume for 1879, Dr. M. Tidy; in volume for 1880, Miss Halcrow and Prof. Frankland, and a second paper by Prof. Frankland alone.

Prof. Miller, in his paper, pointed out that "there is much less agreement between different operators in the exact modes of conducting the details of the analysis than might have been expected." This was in 1865, after the Registrar-General's reports had been given for eight years. The paper is an important one, as it was written "with the hope of contributing something towards facilitating greater uniformity in practice, and of adding precision to the results obtained," and the methods referred to were selected "from every available source." The subjects referred to, include:—(1) The use of the two-foot tube for testing clearness; (2) the arbitrary scale of colour; (3) amount of sediment; (4) taste; (5) odour; (6) hardness; (7) the determination of the amount of organic matter, "as it is often loosely termed," by evaporation and incineration; (8) the use of potassic permanganate (to which four pages is given); (9) the gaseous constituents; (10) estimation of ammonia; (11) estimation of nitrites; (12) estimation of nitrates.

Prof. Frankland's paper, in 1866, gives an explanation of the methods employed by him in the analysis of metropolitan waters. The details of the process for determining by potassic potassic permanganate, the amount of oxygen required to oxidise the organic matter present are given, and the paper is accompanied by five charts, which show the monthly fluctuations. Messrs. Wanklyn, Chapman, and Smith (1867), after stating that the processes employed in water analysis had never been properly investigated, criticise the value of the processes and propose the ammonia process.

The paper by Prof. Wanklyn alone is in verification of the previous paper. Prof. Frankland and Mr. Armstrong (1868), drew attention to the "formidable difficulties" which surround water analysis, and give the results of two years' work on the value of the following determinations:—1. The estimation of total solid constituents. [The omission of sodic carbonate is recommended]. 2. The estimation of organic and other volatile matter. [The difficulty of determining the meaning of loss on ignition is mentioned]. 3. Determination of the amount of oxygen necessary to oxidise the organic matter. [The untrustworthiness of the permanganate process is particularly mentioned]. 4. Estimation of nitrous and nitric acids. 5. Estimation of ammonia. The processes proposed as substitutes are then given. Messrs. Wanklyn, Chapman, and Smith, in their paper, deal critically with this paper, and write in vindication of their process. The paper by Dr. Tidy (1879) includes a description of a new process, which he calls the oxygen process, and in this the real value of the permanganate test is entered into at considerable length. The uncertainty of a colour test, owing to the fact that so many people suffer from partial colour-blindness, is specially dwelt upon.

The ignition process, the combustion process, and the ammonia process, are all considered critically.

The examination of the waters of the London Companies, by Messrs. Crookes, Odling, and Tidy, is made in accordance with the views expressed in this paper. They give four examinations a month of each of the companies, and, in the spring of 1882, issued a set of coloured charts, summarising the results of March (including part of February) to December, 1881.

It will be noticed in the reports that all analysts, in addition to their results, give expression to opinions which involve phsiological and pathological considerations.

* Then, for eight years, there is no paper of importance.

NOTICES OF BOOKS.

The Electric Lighting Act, 1882. By Clement Higgins, M.A., F.C.S., Recorder of Birkenhead, and E. W. W. Edwards, B.A., Barrister-at-Law. London: W. Clowes and Sons. (Lim).

Whatever may be the future of electric lighting, now that such vast sums of money have been embarked in this new scientific industry it is at least necessary that those Local Authorities, Companies, and others interested in this mode of lighting should make themselves acquainted with the legal points of the subject as they stand at present.

This small work before us has been drawn up as a legal guide for the assistance of those concerned in the installation of electricity for industrial purposes, and contains "The Electric Lighting Act, 1882," "An Act to facilitate and regulate the supply of electricity for lighting and other purposes in Great Britain and Ireland," "the Board of Trade rules, the Incorporated Acts, and cases decided thereon, together with such explanatory notes as have occurred to the authors after a careful study of the legal and technical aspects of the subject." The numerous legal and scientific notes that occur throughout the text will be found of much service in comprehending the technical points of the Act. For instance, regarding the safety of the public from personal injury, or from fire, or otherwise, we have the report of the Committee appointed by the Council of the Society of Telegraph Engineers and Electricians, with the rules and regulations they recommended for securing safety from dynamos and lamps, and the points to be attended to in the wires and connections.

As to the limitation of the prices to be charged for the supply of electricity, we have in a lengthy note the evidence and reports of some of the best authorities on the matter of cost of installation and working for different areas. Practical electricians, however, will require more extended experience than they at present possess on this subject before definite ideas can be arrived at for fixing the cost to consumers.

Under Section 23 of this Act, which states that "any person who maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses any electricity shall be guilty of simple larceny and punishable accordingly," the authors give in a note extending over several pages a pretty clear explanation of the terms electromotive force, resistance, quantity, &c., and the units adopted for the measurement of electricity, concluding with a short account of the electrolytic processes that have been suggested as meters to prevent dishonesty on the part of the consumers. As it is the book and not the

wisdom of our legislators that we have here to deal with, we can only say that the arrangement of the work and the copiousness of the notes and references will render it an invaluable guide to the legal points of electric lighting as they are at present.

Technisch-Chemisches Jahrbuch, 1881-1882. (Year-Book of Technological Chemistry.) By Dr. Rud. Biedermann. Berlin: Julius Springer.

In these days of statistics and averages it might afford one no little amusement, not to mention the profitable information that might be acquired, by an investigation of the vast number of patents granted in a single year in any industrial country, and tracing out as far as possible the ratio of the practically successful to the unsuccessful ingenious contrivances of the inventive faculty of man. Judging by the contents of the small work before us, the task, however profitable it might be, would not be an easy or a small one.

Here we have in a compact and handy form a record of the progress of practical chemistry during twelve months as indicated by the patents granted for improvements, chiefly in the German Empire. This Year-Book, as the compiler tells us, forms an illustrated report of the improvements that have been made in technological chemistry during the period comprised between July 1st and the end of the following June, together with short notices of investigations of technological interest published in the scientific journals during the same period. The first few pages of the book contain metallurgical and other statistics relating to German industry. The greater portion of the remainder of the volume is divided into sections, each devoted to a special technological subject, as iron, zinc, sulphuric acid, glass, explosives, dyestuffs, &c., containing brief abstracts of the more important patents granted for improvements in these industries, a few statistics for the past year being appended to each.

A special chapter is given to improved forms of apparatus employed in the various branches of industrial chemistry, such as filter-presses, pulverisers, temperature regulators, galvanic batteries, and so forth. In the final chapter we have a very complete catalogue of the works on chemistry and physics recently published in England, Germany, and France.

Such a mass of information as is here collected together, and arranged in so small a compass, cannot fail to be of considerable utility to the technologist or inventor, affording as it does a survey of the most recent advances in practical chemistry made in Germany. The value of this work to the practical man is increased by the presence of 374 very neatly executed drawings of the machines and apparatus described in the text.

Technologisches Wörterbuch in englischer und deutscher Sprache. (Technological Dictionary in English and German.) By Gustav Eger. Brunswick: Frederick Vieweg and Son.

The great impetus given to technology within the last thirty years by the introduction of scientific methods of precision into manufacturing processes, and the vast metallurgical and chemical industries that have sprung into existence, have rendered intimate commercial intercourse with our neighbours and competitors a matter of necessity. The demand thus created for such dictionaries as this has been the means of bringing forth compilations innumerable of commercial and technical phrases, of various degrees of quality and usefulness. The present addition to the stock professes to contain the terms and locutions employed in architecture, civil, military, and hydraulic; chemistry; mining and metallurgy; mineralogy; shipbuilding, &c., &c., and consists of two parts, English German and German-English.

The first part now before us is edited by G. Eger in connexion with the well-known English Chemists, Drs. Bedson, Burghardt, Carnelly, Lunge, J. J. Hummel, and W. C. W. Williams, and has been technically revised and enlarged by O. Brandes.

From a careful examination of the contents of this work, especially the words relating to chemical science, we feel sure that it does not profess too much, and we have no doubt that it will be found a useful and reliable technological dictionary of the two languages.

The distinctness of the printing, so requisite in a book of this description, is all that could be desired, but for much handling a stronger binding than the present possesses would be absolutely necessary.

CORRESPONDENCE.

CHEMICAL NOMENCLATURE AND NOTATION.

To the Editor of the Chemical News.

Sir,—The last number of the Chemical News contains a reprint of the instructions, with reference to the above subject, issued by the Council of the Chemical Society. With many of these instructions I cordially concur, but from several of them I strongly dissent, for reasons which will be specified below.

As regards the name to be given to common salt, the Instructions recommend "*sodium chloride*," and go on to advise, as may be clearly inferred, that "sodic," or a general termination in *ic*, is objectionable. It nevertheless appears to me that names having the latter characteristic are much to be preferred.

In the first place, may I remind your readers that one of the most systematic nomenclatures ever constructed was the one devised by the father of an existing notation, viz., Berzelius? It was published by him in the *Journal de Physique*, in a Latinised form, and throughout it nouns are qualified by adjectives, the common termination of the latter being *icum* (*ic*). The nomenclature adopted in England was for many years a literal translation from the French: it abounded, as we all know, with such barbarisms as "chloride of sodium," which are not English at all, and have long been abandoned by every systematic writer. The process of abandonment was accelerated by the action of the Chemical Society, whose Council, many years since, placed the whole question in the hands of a Committee, consisting of Professors Miller, Williamson, Foster, and others. The Committee, fortunately as I think, were not unanimous, and as one important result of this, there was no recommendation as to uniformity. But one practical effect was the revival of the Berzelian nomenclature, and its regular adoption into our own tongue, by the chemists above named, by Professor Frankland, and many of their *confrères* and students; and I need not say that it continues to be extensively employed, and has never been objected to on any tangible grounds. The nomenclature in which noun is prefixed to noun, instead of adjective to noun, is of course much later than the Berzelian, and of late years has subsisted side by side with the English form of the latter. Its success I believe to have been mainly due to its resemblance to the set of names employed in German memoirs, but which our German friends have never dignified with the title of "nomenclature." Historically speaking, names of the "sodium chloride" type have no grammatical pedigree. In the second place, the authors of these terms have, as far as I am aware, adduced no reason for their introduction, excepting that the original designations of constituents are least altered by their plan. But if this reason had any real weight, why stop short at the first word and neglect to restore the second. On logical grounds they should call common salt *not* "sodium chlor*ide*" but "sodium chlor*ine*."

Again, the ordinary grammatical usage of the English language is to qualify by means of an adjective. It is true

that, in common unsystematic parlance, we sometimes make use of such terms as "iron spoon," "copper plate." But these compound nouns furnish no support to the Instruction proposal. "Iron spoon" means "spoon made of iron;" no one supposes that by "sodium chloride" we are to understand "chloride made of sodium." Sometimes the heaping up of nouns leads to almost hopeless confusion. For example, "Take ten parts of hydropotassic sulphate" is intelligible enough; but "Take 10 parts of hydrogen and potassium sulphate" is—can anyone say what it is?

The habitual use of certain names is very apt to stereotype upon the mind the ideas connected with them. Now, chemical science has at present a notation admitted by many to be imperfect, and by some to be largely erroneous. Common salt, for instance, is still written NaCl; and unhappily this is the best—or, rather, least unfortunate—formula we can at present adopt. But what does it obviously suggest to everyone who reads it? Not less than this—that common salt contains sodium and chlorine; and that chlorine and sodium have lost nothing by the act of combination. I hold both these suggestions to be equally unfounded, and am not alone in so doing; yet I cannot help, alas! tolerating the formula. When, however, it is proposed still further to emphasise these suggestions of the formula by embodying them in a name,—a name at least alleging the existence, as yet unproved, of sodium in the salt—then, I consider, we are at an infinite distance from the facts, and our procedure is open to questions of the very gravest character. Such names as "sulphur trioxide" are open to objections of a precisely similar nature.

The Instructions also present some other, though minor, difficulties. Why, for example,—as Williamson remarked long since,—should the term "anhydride" be retained, when the bodies to which it refers are, as frequently as not, obtained in other ways than by the removal of water? Why continue to use the word "equation," when, as everyone will agree, the *thing* referred to is merely an equality?

Lastly, may I venture to suggest that an act of uniformity for a learned Society is in itself undesirable. It is, indeed, in the case of a mobile science like our own, a practical impossibility. If proof of this were needed, it would be found in the fact that the Instructions reprinted in your issue of last week, are admittedly different from those originally (1879) decided on.

I have probably written enough to show that the unanimous assent of all chemists, whose opinion is entitled to be considered, has not been obtained, and is not likely to be obtained. I, therefore, express an earnest hope that the proposed scheme of uniformity may not be pressed. Much as I value and, indeed, esteem the greater part of the Instructions, I claim for myself and others an ample liberty to dissent from any of them.—I am, &c.,

AN OLD FELLOW OF THE CHEMICAL SOCIETY.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 26, December 26, 1882.

Separation of Gallium.—Lecoq de Boisbaudran.—See page 16.

Electro-dynamic Method for the Determination of the Ohm. Experimental Measurement of the Constant of a Long Coil.—G. Lippmann.—This paper does not admit of useful abstraction]

Chemical Studies on Maize at Different Stages of its Growth.—H. Leplay.—A continuation from the last number.

Instantaneous Pressure produced during the Combustion of Gaseous Mixtures.—MM. Mallard and Le Chatelier.—The authors refer to their paper in the *Comptes Rendus* of October 2, 1882, and call the attention of the Academy to certain observations made on the pressures developed by the combustion of gaseous mixtures in closed vessels.

Ammonium Bihydrosulphate.—M. Isambert.—The author infers from his experiments that this compound is separated, on evaporation, into its two elements. At a given temperature, whether in a vacuum or in an inert gas, the decomposition is arrested by a certain pressure of the component gases.

A Case of Physical Isomerism of Mono-chlorised Camphor.—P. Cazeneuve.—The author has already described a mono-chlorised camphor remarkable for its stability. The examination of the mother-liquor from which this compound has been crystallised disclosed a remarkable case of physical isomerism. The new isomer is soft, like common camphor, and forms a paste under the mortar, whilst the normal mono-chlorised camphor is hard and easily pulverisable. Its rotatory power is $[a]_i = +57$, whilst that of the normal compound $[a]_i = +90$. It melts at 100°, but its normal isomer melts at 83° to 84°.

Reduction of Sulphates by the Sulphuraires, and the Formation of Natural Metallic Sulphides.—M. Planchud.—Certain Algæ acting as a ferment have the exclusive power of reducing sulphates; this reduction never takes place in presence of lifeless organic matter. The author thinks that most of the metallic sulphides found in nature, as well as free sulphur, are the result of the same action.

Transformation of Nitrates into Nitrites.—U. Gayon and G. Dupetit.—The authors have detected the existence of certain anærobic microbia, which do not entirely deoxidise alkaline nitrates, with liberation of nitrogen, but merely take away a portion of their oxygen, and convert them into nitrites.

Poisonous Principles of Esculent Fungi.—G. Dupetit.—The author shows that some esculent fungi, such as *Boletus edulis*, *Amanita cæsarea*, and *Agaricus campestris*, are not free from poisonous properties. Their fresh juices, injected subcutaneously, proved fatal to rabbits, rats, and Guinea-pigs. The poisonous principle is a kind of soluble ferment, and is completely decomposed by a temperature of 100°.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xi., Part xi.

Hailstorms and their Origin.—HH. Rinicker and Dössekel.—The following conclusions are drawn from observations made in Switzerland:—Hailstorms are a local phase of extensive electric storms, and come generally from the south-west, west, or north-west. They do not begin in open plains, but only when, after a long series of hot days, thunderclouds sweep over bare or scantily-wooded heights, and are then brought to a standstill over deep, well-cultivated valleys by the action of counter currents. Hail never arises from storms which have swept over dense, elevated woods of the silver fir (*Abies pectinata*). The more closely wooded the slopes which the storm has to pass over, and the more points the predominating kind of tree presents, the more electricity will be withdrawn from the dense masses of water, and the more they will be deprived of the power of forming ice by further condensation. *Abies pectinata* and *A. excelsa* are more effectual than the larch, the Scotch fir, or broad leaved trees. Most hailstorms come to an end when the clouds pass over a dense wood. The size of the hail-

stones is proportional to the height from which they fall. The size of hazel-nuts represents a height of 100 metres, and the size of walnuts 200 metres. Hailstorms may be to a great extent prevented by keeping the mountain ridges well wooded, and thus facilitating an equalisation of electric action.

Fertility of the Soil as connected with the number of Worms Living in the Arable Stratum.—The author considers that a chemical analysis of the subsoil gives no sufficient clue to its degree of fruitfulness if the number of earth-worms is not taken into consideration. He estimates the quantity of the large kind (*Lumbricus terrestris*) at 50 kilos. per *morgen* of arable land. In meadows von Lengerke considers that there are per *morgen* 80 kilos. *L. terrestris* and 250 *L. communis*.

Cause of "Clover-Sickness."—Dr. V. Kutzleb.—The author examines the cause of "clover sickness" occurring in a farm at Winjendorff, and concludes that it cannot be due to a parasitical plant (*Phacidium mediæginis*), since it was in 1880 equally plentiful in fields which showed no trace of "clover-sickness." In 1881 the parasite was much less abundant, but the clover was not more prosperous. The author traces the affection to the want of available potash.

Influence of the Spreading and Heaping of Dung upon the Fertility of Arable Soils.—Prof. E. Wollny.—The author shows that a stratum of farmyard manure protects the soil from excessive alternations of temperature, but acts injuriously upon wet retentive soils, as checking evaporation.

Determination of Fatty Matter in Milk.—Dr. R. Emmerich and D. Ingermann.—Emmerich has compared the gravimetric method with those of Soxhlet and Hoppe-Seyler, and with Feser's optical method, and comes to the result that desiccation with sand and extraction with ether gives results differing from those of Soxhlet by only 0 to 0·4 per cent. Feser's method gives 0·25 to 0·6 per cent in excess.

Examination of Butter with the Margarimeter of Leune and Harbulet.—D. Gaebel.—The instrument is an areometer floating in butter placed in the steam of boiling water. The mark 0 indicates pure butter, and every additional degree that the instrument sinks indicates 1 per cent of foreign fats. The author found that a temperature of 93° to 95° is preferable to 100°, but even then the indications are untrustworthy, a sample of pure butter having on one occasion marked 20°.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., November, 1882.

This issue contains no chemical matter.

Cosmos Les Mondes.
No. 18, December 30, 1882.

This number contains no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 1, July and August, 1882.

Volumetric Determination of Copper, Iron, and Antimony by the Processes of M. F. Weil.—Already inserted.

No. 2, September and October, 1882.

Electro-Magnetic Induction.—Eric Gerard.

Use of the Magnetic Needle for the Discovery of Magnetic Ores.—L. Perard.

A Dynamo-Electric Machine with a Solenoid Inductor and a Continuous Current.—J. F. Plücker.—None of these papers are capable of intelligible abstraction without the accompanying illustrations.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 2, 1882.

Determination of the Cinchona Bases and their Salts.—De Vrij has proposed a modification of his well known method, which is here described at length. A. Christensen considers that if large quantities of cinchonidine are present it is advisable to separate the quinine as far as possible by means of ether, and to precipitate it as herapathite. Drygin's method for separating cinchonidine and its homologues from quinine is merely mentioned. H. Hager tests the cinchona bases by the microscopic examination of the precipitates effected by different reagents. A sophistication of quinine ferro-citrate effected by adding amorphous quinine is detected by converting the separated quinine into neutral oxalate, drying carefully, dissolving in chloroform, and filtering, if needful. If a few drops of water are added to this solution in a test-tube the water remains clear if the sample was genuine, but takes a yellow colour if amorphous quinine is present.

Determination of Chlorides in Urine.—G. Firnig.

Determination of Urea with Sodium Hypobromite.—F. A. Falck.

Detection of Phenol in Urine.—T. and D. Tommasi.

Quantitative Determination of Phenol in Urine.—P. Giacosa.

New Reactions of the Biliary Colouring-Matters.—M. Gerhardt.

Trichloracetic Acid as a Reagent for Albumen in Urine.—A. Raabe.

Determination of Blood-Serum by Circum-Polarisation.—The above papers do not admit of useful abridgment.

Detection of Blood Spots.—An account of spectroscopic, microscopic, and micro-chemical methods for identifying blood spots.

Journal de Pharmacie et de Chimie.
Tome vii., January, 1883.

The Jubilee of M. Dumas.—Taken from the *Comptes Rendus*.

New Facts bearing on the Knowledge of Rabies.—L. Pasteur.—A physiological paper from the *Comptes Rendus*.

The Decomposition of Cyanogen.—M. Berthelot.—From the *Comptes Rendus*.

The Wines of Sugar from a Chemical and Hygienic Point of View.—P. Carles.—The author contends that of all the substitutes for wine the best is that formed by the fermentation of a solution of crystalline cane-sugar poured upon the grapes after their juice has run off. He shows, however, that if glucose is used in place of cane-sugar the product has a dull, flat taste, farinaceous rather than saccharine, with a disagreeable bitter after-taste, and it is, moreover, not free from amylic compounds.

Note on a Brazilian Seed.—A. Riche and A. Rémont. The seed in question, though declared to contain no caffeine, is in a manner recommended for the adulteration of coffee.

Determination of Salicylic Acid in Milk and Butter.—A. Rémont.—Already noticed.

Sulpho-Carbometer for Determining the Quantities of Carbon Disulphide contained in the Alkaline Sulpho-carbonates.—A. Gélis and Thommeret-Gélis.—Already noticed.

Purification of Commercial Zinc Sulphate.—E. Van de Vivère.—The author dissolves the sulphate in water, acidifies with sulphuric acid, transforms any ferrous sulphate present into ferric sulphate by means of a current of chlorine, precipitates a part of the solution with sodium carbonate, and adds the precipitate, previously well washed,

in fractions to the bulk of the liquid, raising the mixture to a boil. The zinc hydrocarbonate eliminates the ferric salt.

Analysis of Aqueous Glycerin.—M. Morawski.—The author heats 2 or 3 grms. of the glycerin with 50 to 60 grms. lead oxide to 130°, until the weight of the mixture remains constant. On multiplying by 1·3429 the increase of weight which the lead oxide has undergone, we obtain the quantity of glycerin contained in the commercial product.

Presence of Allantoine and Asparagine in Young Leaves.—E. Schulze and J. Barbieri.—From the *Journ. für Prakt. Chimie.*

Moniteur Scientifique, Quesneville.
January, 1883.

Industrial Society of Mulhouse (Chemical Section), October 11, 1882:—

M. Noelting communicated on his own behalf and on that of Dr. Witt a memoir on the preparation of amido-azo-para-toluol and its derivatives.

November 15, 1882:—

M. Horace Kœchlin read a note on indophenol and its use in printing and dyeing.

M. Albert Scheurer communicated researches by M. Grosseteste on the weakening of cotton by heat.

M. Scheurer read a letter from M. H. Schmidt, of Rouen, on the direct application of chromate of lead—yellow, orange, and red—upon tissues. This communication is as follows:—

M. Jacquet has lately pointed out a new process for the chemical fixation of chromate of lead as a steam colour. His process is a clever combination of certain little known properties of the salts of lead and chrome. The author points out another method by which chromate of lead may be fixed upon cloth. He has observed that barium chromate and lead nitrate if mixed together are readily capable of double decomposition on being heated. A steam colour may be made up of a thickened mixture of lead nitrate and of the precipitate obtained from barium chloride and potassium dichromate. The kind of decomposition which takes place is far from being the ideal of a perfect and intimate fixation, since one of the two agents exists in the colour in an insoluble condition; nevertheless, by making use of concentrated colours in a fine state of division and perfectly homogeneous, we obtain yellows which bear soaping. The author exhibited a swatch printed with the following colour:—Tragacanth water (200 grms. per litre), 250 parts; lead nitrate, 250 parts; barium chromate paste (50 per cent), 550 parts; water, 50 parts. To obtain chrome oranges by the same reaction the author has mixed the lead nitrate with a certain quantity of lead acetate, a salt which easily loses its acid, and yields the excess of lead oxide necessary for the formation of basic chromate. He has used colours very rich in lead, utilising the fact that a mixture of lead nitrate and lead acetate is far more soluble than either of these salts taken separately. A mixture of 1 kilo. lead nitrate and 1 kilo. lead acetate may be dissolved in the volume of 120 c.c. without the solution crystallising in the cold, whilst not more than 461 grms. lead nitrate, or 387 grms. lead acetate, separately can be dissolved in a litre of water without crystallisation. The orange colour is obtained with:—Tragacanth water (200 grms. per litre), 500 parts; lead nitrate, 500 parts; lead acetate, 750 parts; barium chromate paste (50 per cent), 1400 parts. By reducing the proportions of lead acetate to 500 or 250 parts yellower shades can be obtained. Lead acetate alone has very little action upon barium chromate. These oranges are more superficially fixed than the yellows, and lose more on washing and soaping. If before steaming they could be calendered the fixation would be more complete, in virtue of the incorporation of the barium chromate in the tissue. Unfortunately, the yellow colour keeps but a little time, and must be printed the same day that it has been mixed, as in twenty-four hours a large quantity of lead chromate forms in the liquid. The orange colour is more stable, and is still fit for use after the lapse of some days. In working with these colours due precautions must be taken against sulphur fumes. The author exhibited swatches which had been soaped for half an hour at 65°.

M. Camille Kœchlin exhibited a swatch printed with coal, finely ground and thickened with albumen. The colour is a smoke-black, which resists soap and all chemical agents.

On Indophenol.—Horace Kœchlin.

Use of Cœruleine in Wool Dyeing.—A. de Montlaur.—These two papers will be inserted in full.

Review of Biological Chemistry.—G. de Bechi and H. Gall.—A series of translations from the *Berichte der Deutschen Chemischen Gesellschaft, the Journal für Praktische Chemie*, &c.

Review of Foreign Chemical Researches.—G. de Bechi and H. Gall.—Translations from the *Journal of the Chemical Society* and the *Berichte*.

Falsification of Alimentary Matters.—This memoir contains interesting proofs that the sophistication of wines is not an art of modern origin.

Bulletin de la Société Chimique de Paris.
No. 10, November 20, 1882.

Double Decompositions of the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical study. The author concludes that in presence of hydracids the acid which develops most heat unites by preference with mercuric oxide. This takes place independently of any pretended force, and of all considerations of solubility or insolubility; mercuric chloride being decomposed as well by hydrobromic and hydrocyanic acid, which form soluble salts, as by hydriodic acid, which forms an insoluble salt. The reaction is total if there are formed no secondary compounds, such as acid salts, hydrates, and double salts; these bodies being, further, such that their formation-heat compensates the inequality of their neutralisation-heats, which cannot happen in case of dilute hydriodic and hydrochloric acids. On the other hand, there is a distribution when the formation-heat of the secondary compounds exceeds the difference of the neutralisation-heats which may occur in three manners. In proportion to the formation-heat of the acid hydrates, whenever the liquids contain some quantity of anhydrous acid (in the decomposition of mercuric cyanides by hydrochloric acid)—in this case, the inverse reaction cannot be carried beyond the proportion of anhydrous acid existing in the liquids; or, in proportion to the formation-heat of the acid salts (hydrobromic and hydrocyanic acids)—in this case, the two inverse reactions limit each other, because the acid salts are in part dissociated, and cannot re-form themselves in a reaction beyond the proportion in which they exist in isolation in the presence of water; or, lastly, in proportion to the formation-heat of the double salts. The distribution is governed by laws a little different, according as it gives rise exclusively to soluble bodies or to precipitates. In the former case the action is exerted according to the total weights brought into contact, whilst in the latter case it depends on the proportions which exist at the contact of the liquid and the precipitate.

No. 11, December 5, 1882.

Russian Chemical Society.—Session of April 1/13, 1882.—The Secretary announced that the Iljenkoff prize for researches on the naphtha of the Caucasus will not be awarded by the Council of the Society of the University of St. Petersburg before 1883. The memoirs must be sent in before January 15/27, 1883.

M. Alexéeff gave an account of the following researches

made in the laboratory of the University of Kiew:—On the Structure of the Nitro-Products of the Fatty Series, by M. Kissel; on Azo-oxybenzol, by M. Moltchanowsky.

M. Alexéeff, in his own name and in that of M. Kissel, described the characters of azo-cuminic acid. This acid is distinguished from other azo-acids by its solubility in alcohol and its power of forming fine dark red crystals melting at 262°.

M. Alexéeff pointed out the error of M. de Marignac in considering the crystalline form of azo-benzol as belonging to the clinorhombic type.

The Secretary read a memoir by M. Lideff on the solubility of ammonium gallate, and one by M. Mestchersky on the separation of barium as a neutral chromate from strontium and calcium. The author considers this method as inapplicable to quantitative determinations.

MM. Lideff and Tihomiroff sent in a paper on the formation of hypochlorites and chlorates by the action of an electric current on metallic chlorides.

M. Jawein, on behalf of M. Abraham, described a modification of Gay-Lussac's burette. To the lower closed part of the apparatus is adapted a movable syphon, by means of which the liquid may be made to flow. It is sufficient to raise or lower this syphon in order to accelerate or retard the flow.

M. Goldstein presented some observations on the law of Dulong and Petit.

M. Mendelejeff, in his own name and in that of M. Andreeff, made a communication on the coefficient of internal friction of the petroleum hydrocarbides. He presented then some remarks on the combustion-heat of the hydrocarbides. To have an exact idea of the relations between thermic phenomena and chemical transformations it is necessary to separate as far as possible the heat produced by the reaction from that which results from physico-mechanical phenomena. He considers the deductions of M. Thomsen on the relations between the structure of the hydrocarbides and their formation-heat too hazardous.

MISCELLANEOUS.

Society of Arts.—The following papers are set down for reading at the meetings of the Society of Arts during the part of the Session after Christmas:—At the Ordinary Meetings—W. K. Burton, "The Sanitary Inspection of Houses;" General Rundall, "The Suez Canal;" Prof. Thorold Rogers, M.P., "Ensilage in the United States;" Sir Frederick Bramwell, F.R.S., "Some Points in the Practice of the American Patent Office;" J. H. Evans, "The Modern Lathe;" A. J. Hipkins, "The History of the Pianoforte;" Prof. George Forbes, "The Electrical Transmission of Power;" D. Pidgeon, "Recent Improvements in Agricultural Machinery;" Wilfred Cripps, F.S.A., "English and Foreign Silver Work, with some Remarks on Hall-marking." In the Foreign and Colonial Section—Edmond O'Donovan, "Life among the Turcoman Nomads;" Rev. J. Peill, "Social Conditions and Prospects in Madagascar;" Robert W. Felkin, "Egypt: Present and to come;" W. Delisle Hay, "Social and Commercial Aspects of New Zealand." In the Applied Chemistry and Physics Section—C. F. Cross, F.C.S., "Technical Aspects of Lignification;" Walter G. McMillan, F.C.S., "Chemical Means for Preventing or Extinguishing Fires;" W. N. Hartley, F.R.S.E., "Self-Purification of River Waters;" R. W. Atkinson, B.Sc., "The Formation of Diastase from Grain by Moulds;" James J. Dobbie, D.Sc., and John Hutchinson, "On the Application of Electrolysis to Bleaching and Printing." In the Indian Section—Charles H. Lepper, "Overland Commercial Communication between India and China, *vid* Assam;" W. S. Seton-Karr, "Agriculture in Lower Bengal: with some Notice of Tenant Right, &c.;" J. M. Maclean, "Private Enterprise in India;" C. Purdon Clarke, "Some Notes on the Domestic Architecture of India."

MEETINGS FOR THE WEEK.

MONDAY, Jan. 22.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 23rd.—Royal Institution, 3. "Primæval Ancestors of Existing Vegetation," by Professor W. C. Williamson.
—— Royal Medical and Chirurgical, 8.30.
—— Institution of Civil Engineers, 8.
WEDNESDAY, 24th.—Society of Arts, 8. "The Suez Canal," by Lieut.-Gen. Rundall, C.S.I., R.E.
—— Geological, 8.
THURSDAY, 25th.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
—— London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "Technical Aspects of Lignification," by C. F. Cross, F.C.S.
FRIDAY, 26th.—Royal Institution, 8. "Recent Work on Starfishes," at 9, by Mr. G. J. Romanes.
SATURDAY, 27th.—Royal Institution, 3. "Henry and John Lawrence, 1849—1857," by Mr. R. Bosworth Smith.
—— Physical, 3. "On Liquid Slabs," by Dr. F. Guthrie. "Absolute Measurement of Electrical Resistance," by Prof. G. Carey Foster. "Spectra formed by Carved Diffraction Gratings," by W. Baily.

EDITED BY HENRY WATTS, B.A., F.R.S.,
Editor of the Journal of the Chemical Society.

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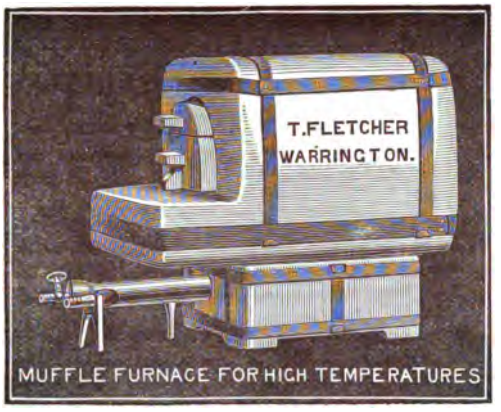

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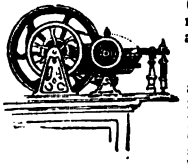

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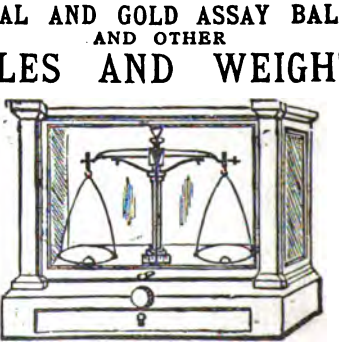

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1209.

NOTE ON A MONO-BROM-HYDRIN OF GLYCEROL.

By V. H. VELEY, M.A. (Oxon.).

The brom-hydrins of glycerol have hitherto received but little attention from chemists. By the action of phosphorus tri- or penta-bromide on glycerol, Berthelot and De Luca (*Ann. Chim. Phys.* [3], 48, 304) obtained a mono-brom-hydrin (b.-p. 180° under 10 m.m. pressure), a dibrom-hydrin, and other products. By the direct addition of bromine to allyl-alcohol a dibrom-hydrin,—

$$CH_2Br.CHCHBrCH_2OH,$$

has been prepared by Munder and Tollens (*Ann. Chem. Pharm.*, 167, 224), and others. A few years ago the author studied the action of hydrobromic acid on glycerol: as he has been unable to continue his researches, it is thought not unadvisable to publish this short note.

Dry hydrobromic acid was passed into glycerol, which had been kept over sulphuric acid for several months, until the liquid was saturated with the gas. The crude product was washed with a concentrated solution of potash, and finally distilled under reduced pressure. After several rectifications a mono brom-hydrin, $C_3H_7BrO_2$, was obtained in the pure state. It is a neutral, oily liquid, boiling at 160° under a pressure of 60 m.m., possessing a faint aromatic smell, insoluble in water, readily soluble in ether. It does not solidify at −15° C.; sp. gr. compared with water at 4° C. = 1·717. Before complete purification it displayed a remarkable green fluorescence; after keeping for some months the same phenomenon was observed. The following results were obtained on analysis:—

	Result.	Theory.
Carbon	23·05	23·22
Hydrogen	4·8—4·88	4·51
Bromine	51·35	51·60
Oxygen	—	20·67
		100·00

On oxidation with chromic acid mixture it is converted into monobromacetic acid. Experiments were made with a view of converting the brom-hydrin by nascent hydrogen into a three-carbon glycol, and thus deciding between the two possible formulæ—

$$CH_2Br.CHOHCH_2OH \text{ and } CH_2OHCHBrCH_2OH;$$

but from the crude product, obtained by acting upon the mono-brom-hydrin with sodium amalgam and a large excess of water, only acrolein was isolated.

NEW RESEARCHES ON CHLORINE AND BROMINE.

Preliminary Communication.

By CARL LANGER and VICTOR MEYER.

The researches of the last years on the dissociation of the halogens have hitherto yielded decisive results only in case of iodine. V. Meyer has succeeded in carrying the reduction of its density to 4·5,—the half of the theoretical value—and Crafts and Meier have found that this density cannot be further diminished by any increase of temperature or decrease of pressure. Hence it can be considered as decided that the cause of the decrease of density lies in a progressive dissociation of the iodine molecule.

Such a proof has not yet been furnished for the other two halogens; it can only be inferred from existing observations that the molecules of bromine and chlorine are likewise dissociated at a red heat, but that the dissociation begins at a much higher temperature than in the case of iodine. The lowest density obtained for chlorine in trustworthy experiments in the Perrot furnace is 2·05 in place of the normal value 2·45, whilst for bromine, applied in the free state, certain figures have not yet been obtained.

The authors have begun a new series of experiments to decide whether, under favourable conditions, the densities of chlorine and bromine can be reduced to the half, and whether such reduction, if reached, is the ultimate limit of diminution. In these experiments they have abandoned the process of gaseous displacement as employed by V. and C. Meyer, and instead of employing platinous chloride and platinum bromide, they operate with chlorine and bromine, obtained in the ordinary manner and carefully purified.

The means which they employ, instead of a further increase of temperature (at which the containing vessels would be decidedly softened), consists in the dilution of the heated vapour with an indifferent gas. A notable result may be obtained by this method if we may judge from the results obtained by Horstmann in case of acetic acid (*Berichte*, 3, 78). The gases come in contact only with glass and porcelain, and the chlorine and bromine employed before entering the experimental tube are passed through water, sulphuric acid, and phosphoric anhydride. The bromine had been carefully purified, and was finally distilled in a fractionating flask with a Geissler thermometer, ground into the condenser, and was found to have a perfectly constant boiling-point. The chlorine was prepared with potassium dichromate and hydrochloric acid, and was mixed with the dilution-gas (carbonic anhydride) in a glass gasometer. The porcelain apparatus has been excellently well prepared by Gosse, of Bayeux, and Franz Müller (Geissler's successor) has furnished glass taps which fit air-tight without any lubricant. The working temperatures were: The air of the room, 14°; watery vapour, 100°; Fletcher's furnace, without blast, about 900°; the same with the blast, about 1200°. The density of the undiluted chlorine was at 100° = 2·50; the same, diluted with 5 vols. air = 2·51; diluted with 15 vols. of air = 2·46. The density of undiluted chlorine at 900° = 2·49, 2·46, 2·41, 2·46; and at 1200° = 2·41, 2·42, 2·45, 2·47, 2·44. All these figures agree well with the normal value of Cl_2, 2·45.

The authors give results as to the density of bromine at low temperatures and great dilution. Bromine boils at 63°, and, as Jahn has proved (*Ber. K. Akademie, Vienna*, March, 1882), possesses, at temperatures which do not lie very high above its boiling-point, a much higher density than the calculated value. It only falls to the normal figure for Br_2 at 230°, *i.e.*, 170° above its boiling-point. Jahn worked with undiluted bromine. If the author's supposition that dilution would promote the dissociation of the halogen molecules be correct, it was to be expected that bromine, much diluted, would show a normal density at low temperatures. This has been fully confirmed. Bromine, diluted with ten times its volume of air, has, at the common temperature of a room, or about 50° below its boiling-point, the exact density calculated for Br_2.

The authors add a few remarks on chlorine. As far back as 1880 it was shown by the concordant experiments of Crafts, V. Meyer, and Züblin, that chlorine gas prepared in the ordinary manner undergoes up to 1200° no diminution of its density, or but very little. V. Meyer showed that the halogen, if employed in the form of platinous chlorine, retains its calculated density, 2·45, only up to a bright red heat, above which it shows smaller values, which, at about 1400°, fall to 2·05. This fact, which gave rise to the hypothesis that nascent chlorine

is more easily dissociated than the pre-formed element may be, in the opinion of the authors, more simply explained by the conditions of the experiment. In the experiments of V. Meyer and Züblin the pre-formed chlorine was conducted into the apparatus in such a manner as to fill it entirely, and consequently was examined undiluted and possessed the normal density. The platinous chloride was introduced into the apparatus only in such quantity that the chlorine evolved filled the vessel to one-third, or at the utmost to one-half, and was consequently abundantly mixed with air, the dilution occasioning the dissociation observed. Hence we see why M. Crafts, who introduced pre-formed chlorine gas into the apparatus, obtained only a very trifling reduction of density, about 3 per cent.—*Berichte Deutsch. Chem. Gesell.*, xv., 2769.

ON INDOPHENOL.

By M. HORACE KŒCHLIN.

M. O. Witt had drawn the author's attention to Mr. Meldola's violet, and to the attempts which had been made to apply this colour. M. Witt had tried a mixture of nitroso-dimethyl-aniline hydrochlorate and of resorcine or orcine. These compositions were deficient in stability and underwent decomposition in the cold. This inconvenience compelled the author to abandon them, and to try another order of compounds. By substituting for resorcine α-naphthol dissolved in soda the nature of the reaction was changed, but in place of a violet the result was a blue of the tone and the solidity of indigo. The reaction was capable of being reproduced on the fibre, which must be impregnated with α-naphthol sodium at 50 or 100 grms. per litre, and then printed with nitroso-dimethyl-aniline, 50 grms. to a litre of thickening, with 50 grms. of stannous oxide in paste, to steam for fifteen minutes, and to chrome.

The author placed the practical working out of his discovery in the hands of Cassella, of Frankfort, and Durand and Huguenin, of Lyon. These manufacturers generally oxidise a mixture of amido-dimethyl-aniline and of α-naphthol-sodium. Their product is a crystalline powder with a metallic reflexion or a grayish paste, constituting the stannous salt of the reduced compound. Indophenol is insoluble in water; it dissolves in alcohol with a blue colour, and in glacial acetic acid; sulphuric acid dissolves it with a red colour, but decomposes it. Alkalies are without action upon indophenol prepared with α-naphthol, but decompose that from β-naphthol. The mineral acids, on the contrary, decompose the indophenol from α-naphthol, but do not act upon the blue from β-naphthol. There are no other isomers producing colouring-matters whose properties are so different. The indophenol obtained from phenic acid is brighter, and dissolves in sulphuric acid with a blue colour.

From resorcin M. Ch. Mayer has obtained a violet indophenol of great solidity, but wanting in brightness, and difficult to apply on account of its slight solubility.

Indophenol is easily reduced by the sulphides, stannous chloride, &c.; the product of the reduction is very soluble in acetic acid and in the alkalies.

For fixing indophenol upon cotton we print on a mixture of indophenol and tin acetate duly thickened, air and wash, or steam and chrome.

In the first case the author proceeds as follows: he prints the following colour, which has been heated to 50° for half an hour and cooled:—

Indophenol	2000 grms.
Acetic acid, 8° Tw.	10 litres.
Tin acetate, 30° Tw.	10 „
Gum	8000 grms.

He ages for twenty-four hours, steams two minutes, chromes at 50° for two minutes (10 grms. potassium dichromate per litre of water), and soaps. The steam and the chroming may be omitted, but the colour is less intense.

In the second case he prints:—

Indophenol	500 to 1000 grms.
Acetic acid, 8° Tw.	5 litres.
Tin acetate, 30° Tw.	5 „
Starch	750 grms.
Calcined starch	750 „
Tin nitro-muriate, 113° Tw.	250 c.c.
Ammonia	250 „
Stannous oxide, paste	1 litre.
Black liquor, 14° Tw.	½ „

The pieces are then aged for ten to twelve hours, steamed without pressure for two or three hours, according to the accompanying colours, chromed for two minutes at 50°, with the same strength of chrome as given above, washed, and soaped. More or less of the double salt of tin and ammonia, as well as of the stannous oxide, must be added according to the indophenol. Without these additions the indophenol does not bear steaming.

For dyeing wool, silk, and cotton, mordanted with ammonium sulpholeate, the author dilutes the following bath with water:—

Acetic acid	1 litre.
Indophenol	200 grms.
Tin acetate, 30° Tw.	1 litre.
Calcium acetate, 26° Tw.	½ „
Black liquor, 14° Tw.	100 c.c.

Raise to a boil.

The author works the pieces for two hours at 60°, washes, and chromes at 50° for five minutes with 5 grms. dichromate per litre. The pieces are grey as they leave the kettle.

Wool slightly chlored dyes much more readily, giving a blue, which is deeper and resists boiling soap better. Or the wool may be dyed in an alkaline flot by steeping it for two minutes at 50° in—

Water	1 litre.
Soda crystals	200 grms.
Indophenol	25 „
Glucose	25 „

Hang it in the air for a few minutes, and take through bichromate of potash.—*Moniteur Scientifique.*

ON CERTAIN TETRA-SUBSTITUTED PROPIONIC ACIDS.

By HENRY B. HILL and CHARLES F. MABERY.

In a previous communication* one of us has already mentioned the fact that the di-bromacrylic from muco-bromic acid, unlike the di-chloracrylic acid of Wallach, takes up a molecule of bromine with readiness and forms a tetra-brom-propionic acid. We were led to undertake a more complete study of the tetra-brompropionic acid. We were led to undertake a more complete study of the tetra-substituted propionic acids, especially with the hope that the study of those containing two different hologens might throw some light upon the position of the halogen atoms in the di-substituted acrylic acids formed from muco-bromic and muco-chloric acids. After our investigations were concluded, Mauthner and Suida† published in the *Proceedings af the Vienna Academy* a paper entitled

* *American Chemical Journal*, 3, 116; and *Proceedings American Academy*, 16 (N.S. viii.), 197.

† *Sitzungsberichte der kk. Akademie Wien*, 83, 273.

"*Ueber gebromte Propionsauren und Acrylsauren*," in which they anticipate us in the publication of a portion of our work. Since they were perfectly well aware that, in studying derivatives of a substituted acrylic acid which they asserted, although without adequate proof, was identical with that obtained from muco-bromic acid, they were trespassing upon ground which one of us had already fully reserved, we think it advisable, although it involves a certain amount of repetition, to give our results in full, more especially since we are able to correct their work in several important particulars.

Tetra-brompropionic Acid.

Tetra-brompropionic acid can readily be made by the addition of bromine to di-bromacrylic acid at ordinary temperatures.* We have prepared it by adding to a solution in chloform the calculated amount of bromine. On standing, the addition product gradually separates, often in large, well-formed prisms. The amount of the product thus obtained was about 90 per cent of the theoretical yield. After re-crystallisation from chloroform the substance was dried over sulphuric acid.

I. 0·5480 grm. substance gave 0·1837 grm. CO_2 and 0·0286 grm. H_2O.

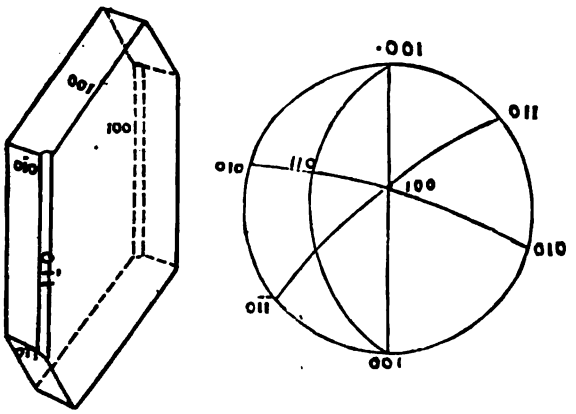
II. 0·1775 grm. substance gave 0·3432 grm. AgBr.

	Calculated for $C_3H_2Br_4O_2$.	Found. I.	Found. II.
C	9·23	9·14	—
H	0·51	3·58	—
Br	82·04	—	82·28

Tetra-brompropionic acid crystallises in prisms of the triclinic system, which melt at 125-126°. It is very soluble in alcohol or ether, readily soluble in hot chloroform, carbonic di-sulphide, or benzol, and separates in crystals as these solutions cool. In ligroin it is sparingly soluble. Under water it melts at a very low temperature to a colourless oil which dissolves freely on heating.

For a crystallographic study of the substance we are indebted to Dr. W. H. Melville.

CRYSTALLINE FORM OF TETRA-BROMPROPIONIC ACID.



Triclinic System.

Forms, [100][010][001][011][110].

Elements: Macro-diagonal $a = 1·507$
Brachy-diagonal $b = 1$
Vertical axis $c = 0·934$
Angles of axes XY = 94°59'
XZ = 104°28'
YZ = 74°20'

Angles between Normals.

	Observed.	Calculated.
100 and 010	= 80° 48'	
010 „ 011	= 56° 3'	
011 „ 001	= 48° 51½'	Fundamental angles.
100 „ 011	= 77° 21½'	
100 „ 110	= 57° 25'	
100 „ 001	= 77° 1'	76° 21'.

Argentic Tetra-brompropionate, $AgC_3HBr_4O_2$. Argentic nitrate added to a solution of the acid in dilute alcohol precipitates the silver salt in clustered needles, which may further be increased in quantity by the cautious addition of ammonic hydrate. The salt is extremely unstable, forms argentic bromide on warming, and blackens rapidly in diffused light.

1·2182 grm. of the salt dried over H_2SO_4 gave 0·4744 grm. AgBr.

	Calculated for $AgC_3HBr_4O_2$.	Found.
Ag	21·78	22·38

Baric Tetra-brompropionate, $Ba(C_3HBr_4O_2)_2 . 2H_2O$. An aqueous solution of the acid dissolved baric carbonate rapidly in the cold, and if the solution was not warmed there was no noticeable decomposition. On spontaneous evaporation at ordinary temperatures the barium salt was left in clusters of flattened needles. When dried by exposure to the air they contained two molecules of water, which they lost over sulphuric acid.

I. 0·7239 grm. of the air-dried salt lost over H_2SO_4 0·0272 grm. H_2O.

II. 0·7087 grm. of the air-dried salt lost over H_2SO_4 0·0259 grm. H_2O.

	Calculated for $Ba(C_3HBr_4O_2)_2.2H_2O$.	Found. I.	Found. II.
H_2O	3·79	3·76	3·66

0·6756 grm. of the salt dried over H_2SO_4 gave on ignition with H_2SO_4 0·1742 grm. $BaSO_4$.

	Calculated for $Ba(C_3HBr_4O_2)_2$.	Found.
Ba	14·97	15·16

Calcic Tetra-brompropionate, $Ca(C_3HBr_4O_2)_2$.—The calcium salt, made by neutralising an aqueous solution of the acid with calcic carbonate and allowing the solution to evaporate spontaneously, crystallised in needles which proved to be anhydrous. The salt freed from moisture by pressure did not materially lose in weight when exposed to the air, and when air-dried lost nothing over sulphuric acid.

I. 0·5065 grm. of the salt dried over H_2SO_4 gave on ignition with H_2SO_4 0·0888 grm. $CaSO_4$.

II. 1·0886 grm. of the salt dried over H_2SO_4 gave 0·1850 grm. $CaSO_4$.

	Calculated for $Ca(C_3HBr_4O_2)_2$.	Found. I.	Found. II.
Ca	4·89	5·16	5·00

When a solution of baric tetra-brompropionate was heated baric bromide was formed, carbonate dioxide escaped, and at the same time the liquid became turbid through the separation of a colourless oil.* On distilling the liquid the oil passed readily over with steam, and since from the method of its formation there could be little doubt that it was tribromethylen, for identification it was immediately converted into its dibromide by the addition of bromine. The crystalline addition product which was thus obtained when purified by re-crystallisation melted at 53°, and gave on analysis a percentage of bromine which showed it to be penta-bromethan.

0·1696 grm. substance gave 0·3766 grm. AgBr.

Calculated for C_3HBr_5.	Found.
94·12	94·48

* Manthner and Suida assert that the di-bromacrylic acid will take up no bromine in the cold. They prepared tetra-brompropionic acid by heating to 100° with undiluted bromine. That the bromine is very readily taken up one of us first mentioned several years ago (*Berichte der deutsch. chem. Gesellsch.*, 12, 657).

* Manthner and Suida assert that this decomposition also takes place on long standing at ordinary temperatures. They were therefore able to isolate no salts. We have never observed any decomposition in the cold.—*Loc. cit.*, p. 284.

This decomposition may therefore be expressed by the equation :—

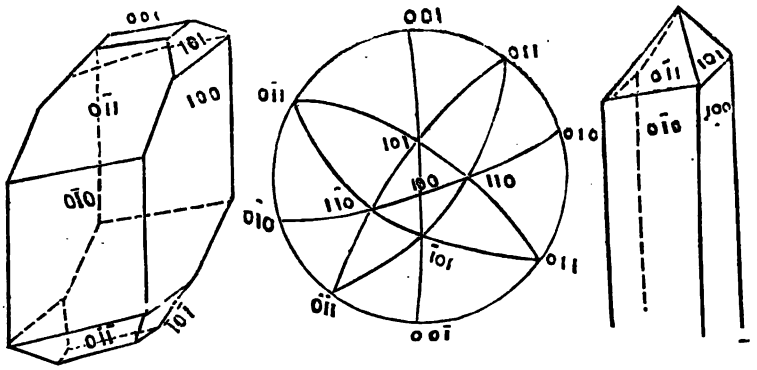
$$Ba(C_3HBr_4O_2)_2 = BaBr_2 + 2CO_2 + 2C_2HBr_3.$$

By the action of an alcoholic solution of potassic hydrate upon tetra-brompropionic acid a molecule of hydrobromic acid is removed, and there results the tri-bromacrylic acid, melting at 118°, which we have already described.* Dr. W. H. Melville kindly made a crystallographic study of the crystals which we obtained, and established their identity with those he had previously examined, which were prepared by the addition of bromine to brom-propiolic acid. A description of the crystalline form of tri-bromacrylic acid Dr. Melville presents in a separate communication.

	Calculated for $C_3H_2Cl_2Br_2O_2$.		Found. I.	II.	III.
C	11·96		11·91	—	—
H	0·67		0·90	—	—
Cl	23·59	76·74	—	76·93	23·77
Br	53·15				52·90

This α-dichlor-dibrompropionic acid crystallises in well-formed triclinic prisms, which melt at 94° to 95°. It is readily soluble in water, alcohol, or ether; in carbonic disulphide, chloroform, or benzol it dissolves less freely. From a solution in carbonic disulphide it could be obtained by slow evaporation in well-formed crystals, whose study was kindly undertaken by Dr. W. H. Melville.

CRYSTALLINE FORM OF α-DICHLOR-DIBROMPROPIONIC ACID.



Triclinic System.

Forms, [100] [010] [001] [101] [011] [10$\bar{1}$] [01$\bar{1}$]; [110] and [1$\bar{1}$0] often present.

* Elements: Macro-diagonal $a = 1{\cdot}023$
Brachy-diagonal $b = 1$
Vertical Axis $c = 1{\cdot}052$
Angles of Axes $XY = 91°$
$XZ = 76° 31\frac{1}{2}'$
$YZ = 108° 52'$

Angles between Normals.

	Observed.	Calculated.
100 and 010 =	93° 37′	
100 „ 101 =	52° 58′	
010 „ 011 =	34° 57′	Fundamental angles.
010 „ 101 =	77° 19′	
101 „ 011 =	58° 46′	
100 „ 10$\bar{1}$ =	38° 32′	38° 41′
011 „ 001 =	35° 21′	35° 52′
001 „ 01$\bar{1}$ =	55° 45′	55° 30′
100 „ 01$\bar{1}$ =	101° 3′	100° 39′
100 „ 011 =	98° 49′	98° 38′
101 „ 101 =	87° 34′	88° 20′
10$\bar{1}$ „ 011 =	50° 32′	50° 30′

Argentic α-Dichlor-dibrompropionate, $AgC_3HCl_2Br_2O_2$. The silver salt falls, on the addition of argentic nitrate, to an aqueous solution of the acid, in flattened jagged needles which are readily decomposed by heat. They could, however, be dried over sulphuric acid without any essential decomposition, as is shown by the following analysis :—

* Through an error the ratios of the fundamental parameters were originally given in the *Berichte des deutsch. chem. Gesellsch.*, 14, 1680: $a : b : c = 1{\cdot}034 : 1 : 1{\cdot}062$.

α-Dichlor-brompropionic Acid.

In studying the dichlor-acrylic acid made from mucochloric acid, W. Z. Bennett and one of us found that even at 100° it would not take up bromine when dissolved in chloroform.† Subsequently it appeared from the experiments of C. W. Andrews that the substituted propionic acid could readily be made by the action of undiluted bromine, although circumstances at the time prevented a detailed study on his part. As a precise characterisation of this addition-product seemed of interest we undertook its preparation and investigation.

Pure dichlor-acrylic acid melting at 85° to 86° was heated with a molecule of bromine for several hours at 100°. The almost colourless product of the reaction was pressed thoroughly with paper and purified by crystallisation, at first from carbonic disulphide, and finally from chloroform. When dried over sulphuric acid this substance gave on analysis percentages agreeing closely with those required by the formula $CH_2Cl_2Br_2O_2$. In the indirect determination of the halogens we used the extremely convenient and accurate method recently described by Mr. L. P. Kinnicutt.‡

I.§ 0·8124 grm. substance gave 0·3550 grm. CO_2 and 0·0665 grm. H_2O.

II. 0·1715 grm. substance gave 0·3775 grm. AgCl+AgBr.

III. 0·4790 grm. substance gave 1·0559 grms. AgCl+AgBr.

From this by reduction was obtained 0·6887 grm. Ag.

* *American Chemical Journal*, 3, 178; and *Proceedings American Academy*, 16 (N.S. viii.), 216. Mauthner and Suida assign to the barium and calcium salts of this acid, prepared by them from tetra-brom-propionic acid, formulæ differing greatly from those which we formerly established by our analyses. Since their determinations were made with small quantities of material, we have not thought it necessary to make further analyses in support of our formulæ.

† *American Chemical Journal*, 3, 172; and *Proceedings American Academy*, 16 (N.S. viii.), 211.

‡ *American Chemical Journal*, 4, 22; and *Proceedings American Academy*, 17 (N.S. ix), 91.

§ These analyses were made by Mr. Andrews.

0·4885 grm. of substance gave by precipitation with HBr 0·2231 grm. AgBr.

	Calculated for $AgC_3HCl_2Br_2O_2$.	Found.
Ag	26·46	26·23

Baric α-Dichlor-dibrompropionate, $Ba(C_3HCl_2Br_2O_2)_2$. The barium salt we made by neutralising a cold aqueous solution of the acid with baric carbonate. On evaporation at ordinary temperatures it crystallised in long branching needles, which, when dried by exposure to the air, did not lose materially in weight over sulphuric acid, and contained a percentage of barium corresponding to the anhydrous salt.

I. 0·5069 grm. of the air-dried salt gave 0·1606 grm. $BaSO_4$.

II. 0·5239 grm. of the air-dried salt gave 0·1676 grm. $BaSO_4$.

		Found.	
	Calculated for $Ba(C_3HCl_2Br_2O_2)_2$.	I.	II.
Ba	18·59	18·58	18·81

The barium salt is decomposed by warming, its solution giving products similar to those obtained in the same way from tetra-brompropionic acid. This decomposition, however, we have not as yet studied further.

β-Dichlor-dibrompropionic Acid.

Although dibromacrylic acid assumes a molecule of bromine so readily, we found at first great difficulty in preparing the corresponding addition-product with chlorine. If chlorine gas is passed into melted dibromacrylic acid it is gradually taken up and the melting-point of the acid is slowly changed. After long-continued action a considerable quantity of the dichlor-dibrompropionic acid is formed, but so contaminated with oily by-products that its purification is a matter of some difficulty. This addition of chlorine is, however, rapidly and neatly accomplished if the reaction is allowed to proceed in direct sunlight at 100°. When at this temperature the melted acid becomes nearly solid with separating crystals of the addition product, the chlorination is interrupted. The product which we obtained in this way from pure dibromacrylic acid melting at 85° to 86° was purified by crystallisation first from carbonic disulphide, and finally from chloroform. On analysis it gave the following results:—

I. 0·5183 grm. substance gave 0·2335 grm. CO_2 and 0·0431 grm. H_2O.

II. 0·1547 grm. substance gave 0·3400 grm. AgCl + AgBr. From this by reduction was obtained 0·2214 grm. Ag.

		Found.	
	Calculated for $(C_3H_2Cl_2Br_2O_2)$.	I.	II.
C	11·96	12·13	—
H	0·66	0·92	—
Cl	23·59	—	23·37
Br	53·15	—	53·21

This β-dichlor-dibrom-propionic acid crystallises in oblique prisms which melt at 118-120°, and in its behaviour with solvents closely resembles the α acid. In water, alcohol, or ether it dissolves very easily, but with somewhat more difficulty in carbonic disulphide, chloroform, or benzol. The solution in carbonic disulphide gave by slow evaporation well-developed crystals whose elements Dr. W. H. Melville kindly determined.

Monoclinic System.

Forms, [100] [110] [111] [102].

Elements: Clino-diagonal $a = 2·393$
Ortho-diagonal $b = 1$
Vertical Axis $c = 1·731$
Angle of Axes $XZ = 46° 9'$

Angles between Normals.

Observed.		Calculated.
110 and $\bar{1}10$ =	60° 11′	Fundamental angles.
111 ,, $\bar{1}10$ =	42° 24½′	
111 ,, 110 =	40° 33½′	
$\bar{1}00$,, $\bar{1}10$ =	59° 53′	59° 54½′
111 ,, $\bar{1}11$ =	120° ½′	119° 56′
100 ,, 111 =	88° 57′	88° 47′
102 ,, $\bar{1}10$ =	102° 21′	102° 23′
102 ,, 110 =	78° 5′	77° 37′
102 ,, 111 =	63° 44′	63° 42½′

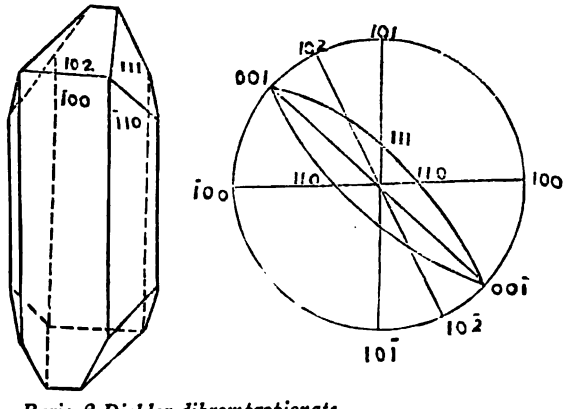
The difference between the α and β acids was further confirmed by a study of the silver and barium salts.

Argentic β-Dichlor-dibrompropionate, $AgC_3HCl_2Br_2O_2$. The silver salt is precipitated in the form of short, thick, pointed prisms, when argentic nitrate is added to an aqueous solution of the acid. It is readily decomposed by heat, but may be dried for analysis over sulphuric acid.

0·4950 grm. of the salt gave on precipitation with HCl 0·1731 grm. AgCl.

	Calculated for $AgC_3HCl_2Br_2O_2$.	Found.
Ag	26·46	26·31

CRYSTALLINE FORM OF β-DICHLOR-DIBROMPROPIONIC ACID.



Baric β-Dichlor-dibrompropionate,
$Ba(C_3HCl_2Br_2O_2)_2.2H_2O$.

The barium salt, which we made by neutralising an aqueous solution of the acid with baric hydrate, crystallised on spontaneous evaporation of its solution in long radiating needles which were very soluble in cold water. When dried by exposure to the air the salt proved to contain two molecules of water which it lost over sulphuric acid.

I. 1·6201 grm. of the air-dried salt lost over H_2SO_4 0·0705 grm. H_2O.

II. 1·5443 grm. of the air-dried salt lost over H_2SO_4 0·0731 grm. H_2O.

		Found.	
	Calculated for $Ba(C_3HCl_2Br_2O_2)_2.2H_2O$.	I.	II.
H_2O	4·66	4·35	4·74

0·8236 grm. of the salt dried over H_2SO_4 gave 0·2616 grm. $BaSO_4$.

	Calculated for $Ba(C_3HCl_2Br_2O_2)_2$.	Found.
Ba	18·59	18·69

These results prove that the α- and β-dichlor-dibrompropionic acids described are essentially different.

	Dichlor-dibrompropionic Acid.	
	α	β
System of Crystallisation.	Triclinic.	Monoclinic.
Melting-point	94·95°	118-120°
Barium salt ..	$Ba(C_3HBr_2Cl_2O_2)$	$Ba(C_3HBr_2Cl_2O_2)_2.2H_2O$.

The barium salt was readily decomposed by warming its aqueous solution. Baric chloride and carbonic dioxide were formed together with a colourless oil, which undoubtedly was a dibrom-chlorethylen. With bromine this oil gave a solid addition product, which, however, we have not as yet prepared in quantity sufficient for complete purification and identification.—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, January 18, 1883.

Dr. Gilbert, F.R.S., President, in the Chair.

The President announced that the following distinguished chemists would be proposed for election at the next meeting of the Society as Foreign Members:—Beilstein, Clève, Debray, Erlenmeyer, Fittig, Helmholtz, Mendelejeff, Lothar Meyer, Victor Meyer. A ballot for the election of ordinary Fellows will also be held at the next meeting, February 1.

The following certificates were read for the first time:—A. C. Abraham, E. Bevan, C. N. Betts, F. J. Cox, A. Collenette, S. Dyson, W. T. Elliott, H. B. Fulton, C. G. Greenfell, B. F. Halford, D. Hooper, W. D. Hogg, H. F. Lowe, T. H. Leeming, J. E. Marsh, W. Newton, C. Rumble, F. Scudder, F. Watts, C. S. S. Webster.

Dr. Roscoe then communicated the substance of a paper entitled "*The Fluorine Compounds of Uranium*," by A. Smithells. Since the preparation of uranium oxy-fluoride by Berzelius the above compounds have been investigated by Carrington Bolton, and more recently by Ditte. As the results obtained by these two chemists do not agree, the present experiments were undertaken to clear up the question. The green uranoso-uranic oxide, U_3O_8, when acted upon by aqueous hydrofluoric acid, gives a voluminous green powder and a clear bright yellow solution. According to Bolton this green powder is UF_4, whilst the yellow solution furnishes, on evaporation, UO_2F_2. Ditte assigns to the green powder the formula UO_2F_2, and to the substance in the yellow solution the composition UF_6+8HF; he also represents the reaction thus—$U_3O_8+18HF=2(UF_62HF)+UO_2F_2+6H_2O+H_2$. The author endeavoured to collect the 2·6 litres of hydrogen which should be, according to Ditte, evolved from 100 grms. of U_3O_8, but found that none came off. He finds that Ditte is also in error as regards the composition of the other bodies, which are, as Bolton stated, UF_4 and UO_2F_2 respectively. When UF_4 is heated in a closed crucible a white sublimate is formed; if after five minutes the crucible is allowed to cool and the sublimate removed, a fresh sublimate is again formed on re-heating, and so on until a residue is left of UO_2. This sublimate is isomeric with the body found in the yellow solution, and is called, therefore, α-uranium oxy-fluoride, UO_2F_2. The author has also investigated the new fluorine compounds obtained by Ditte by fusing U_3O_8 with an alkaline fluoride, and which he stated had the composition UO_2F_24MF and $UOF_44MF+xH_2O$. The author concludes that these compounds have no existence, and that really only fluoxy-uranates were obtained by Ditte.

The Secretary then read a paper "*On a New Method of Estimating the Halogens in Volatile Organic Compounds*," by R. T. Plimpton and E. E. Graves. The authors introduce a weighed quantity of the liquid into the tube of a glass Bunsen burner; the tube of the Bunsen is bent into a U; over the end of the Bunsen is placed a glass trumpet-shaped tube, the other end of which is connected with a U-tube filled with pieces of glass. These are moistened with pure caustic soda solution. A second U-tube similarly charged succeeds the first. To the second U-tube is joined a small wash-bottle containing nitrate of silver. A Sprengel pump is connected with the wash-bottle so that the products of combustion are sucked successively through the two U-tubes, and finally bubble through the nitrate of silver solution. The gas having been lighted the liquid is expelled from the weighing-tube by gentle heating. After all the liquid has been thus driven off and burnt, the soda solution is washed out, and boiled with sulphurous acid to reduce any chlorates, &c., nitric acid is added, and the solution precipitated with silver nitrate. The combustion usually takes fifteen to twenty minutes. About 12 analyses are given with liquids of various boiling-points, the lowest being ethyl-bromide, boiling at 39°, the highest acetylene brom-iodide boiling at 150°. The results agree well with the calculated numbers.

Mr. W. A. Shenstone then read a short paper "*On a Modified Liebig Condenser.*" The Liebig's condenser is placed vertically. To the lower end of the inner tube is fused a short piece of somewhat smaller glass tube. The end of this smaller tube projects upwards about half an inch into the condenser. In this way an annular ledge is formed between the inner wall of the condenser and the outer wall of this smaller tube. This annular space is drained by a narrow glass tube a few inches long, which is fused into the bottom of the condenser like a T-piece. This narrow glass tube slopes gently downwards, and is furnished at its extremity with a stopper. The advantages are first that the apparatus requires less space on the table than the ordinary condensing arrangement, and secondly that when substances have to be digested for some time, and subsequently distilled, no shifting of the apparatus is required. Thus, in the preparation of formic acid by heating oxalic acid with glycerin, the stopper is inserted in the narrow T-tube, and any vapour rising into the condenser, is condensed, trickles down, fills the annular space, overflows, and runs down into the flask. When it is wished to distil the product, the stopper is taken out, and the liquid, instead of running back into the flask, drains off from the annular space down the narrow T-tube into the receiver. The apparatus is made by Cetti and Co.

The Secretary then read a paper "*On Two New Aluminous Mineral Species, Evigtokite and Liskeardite*," by W. Flight. The first mineral comes from the cryolite bed of Greenland. The author gives its formula as $Al_2F_3+2CaF+H_2O$. It resembles chalk or kaolin in its appearance. Liskeardite is obtained as a white crystalline mineral with tinge of blue, from Penzance. It has the formula $3R_2O_3As_2O_5+16H_2O$, R = Al and Fe''''. The author has made a very minute and careful determination of the water expelled at various temperatures.

The Secretary then read a paper "*On the Volume Alteration attending the Mixture of Salt Solutions*," by W. W. J. Nicol. The author has investigated the changes of volume in mixing various proportions of sodium and potassium chlorides, of potassium nitrate and sodium chloride, of sodium nitrate and potassium chloride, and of copper sulphate and potassium sulphate. The experiments show that when two salt solutions which cannot experience double decomposition are mixed, a change of volume takes place due to the different affinity of the salts for water; that double decomposition takes place in solution, and that the volume change is an index, and even a measure, of this decomposition.

The Society then adjourned to February 1.

SOCIETY OF PUBLIC ANALYSTS.

The Annual Meeting of this Society was held at Burlington House on January 17, when the election of Officers and Members of Council took place.

Mr. G. W. Wigner, who has occupied the position of one of the Honorary Secretaries since the formation of the Society, more than eight years ago, was elected President,

and Mr. C. Heisch, Dr. C. A. Cameron, and Dr. Alfred Hill, Vice-Presidents. The new Honorary Secretaries elected are Mr. Bernard Dyer and Mr. Otto Hehner; and other new Members of Council are Mr. A. Ashby, Mr. C. T. Kingzett, and Dr. P. Vieth.

Mr. A. P. Stokes, of Paddington, was elected a Member of the Society.

Mr. HEHNER read a very interesting paper "*On the Analysis of Yellow Wax.*"

The Annual Dinner was afterwards held at the "Criterion," where the Members and their friends passed a very agreeable evening.

NOTICES OF BOOKS.

Die Chemische Kraftquelle im lebenden Protoplasma. (The Chemical Source of Force in Living Protoplasm.) By OSCAR LOEW and THOMAS BOKORNY. Munich: Jas. Ant. Finsterlin.

SINCE synthetical chemistry got its start in 1828 by the discovery, by Wöhler, of the artificial production of urea, so many of those compounds have been formed in the laboratory which were formerly supposed only capable of being produced by the mysterious power called "vital force" with which living organisms were endowed, that the artificial formation of albumen would not seem to be an impossibility for the synthetical chemist. Citric acid and indigo have but recently yielded to his efforts, and sugar, starch, or even albumen, may at some not far distant date be another important victory in this field of research. It is, however, doubtful if substances such as albumen, which plays so important a part in the life of a cell, produced artificially, would possess the same physical properties as those which exist in living organisms. The composition of the two might agree, but to give to the artificial article that organised structure which the natural substance possesses in the active state called life will doubtless transcend the powers of the human intellect.

That there is a chemical difference between living and dead protoplasm, as was first inferred by E. Pflüger, in 1875, from theoretical considerations, is considered by the authors of the present work to be true.

This pamphlet forms the second edition of the authors' work, "The Chemical Cause of Life," with the title changed, and contains the results of their speculations regarding the origin and constitution of albumen, with the experimental evidence they have adduced of a chemical difference existing between living and dead protoplasm. Under the expression protoplasm they understand only the organised watery albumen of the cell-contents, the other substances present being considered merely as mixtures of greater or less importance.

The aim of the work is to prove the existence of an aldehyd group,—

$$-C\overset{=O}{-H},$$

in living protoplasm, which after death undergoes an alteration of molecular structure. In their theoretical considerations formic aldehyd is made the starting-point for obtaining the formula for albumen. The proof of the aldehydic character of living protoplasm is based on the fact that living cells are capable of separating silver from a very dilute alkaline solution of the metal, whilst dead cells give no such reaction. The detailed experiments were made principally with cells of Spirogyra under various conditions, and in two coloured plates appended to the work is shown the influence which living cells exert on the silver solution employed, and the negative results obtained with cells that had been killed by various physical and chemical means. To such a vast subject of enquiry as this is, of which our knowledge is so vague and opinions so divided, we have no doubt that this pamphlet, containing an attempt to establish a chemical difference between dead and living protoplasm, will form an interesting contribution, and probably give rise to further experiment in the same direction.

Through the kindness of the authors we have had the pleasure of examining a number of their prepared specimens, and they would seem to be of great interest from a biological as well as a chemical point of view.

The Retrospect of Medicine; being a Half-yearly Journal containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. LXXXVI., July to December, 1882. London: Simpkin, Marshall, and Co.

THIS volume contains no small quantity of matter of interest to the sanitarian. We find an abstract of an essay on the diseases caused by sewer gas, in which the gaseous products of the decomposition of animal matter are acquitted, when in a diluted state, of causing serious disease. The true morbific agents are very rationally pronounced to be "formed" ferments—microzymes—which are of two classes at least. There are the ferments of putrefaction which may occasion low sore-throat, diarrhœa, and other non-specific diseases common in places exposed to sewage emanations. Then there are what the writer calls the microzymes of specific diseases, such as diphtheria and typhoid fever, which are only incidentally present. It is, however, hinted as at least probable that these more dreaded poisons may be generated *de novo* where sewage is allowed to stagnate. The extraordinary changes which certain microbia have been found capable of undergoing in the course of a few generations lends probability to this view. It is far from unlikely that microzymes normally harmless may, under favouring conditions, develop into the germs of specific disease.

The sanitary value of sulphur is expounded at some length in a paper by M. d'Abbadie, which we have already noticed in an abstract of the *Comptes Rendus*.

Concerning typhoid fever and diphtheria, we find the remark that "these diseases have grown with the growth and developed with the development of our present water-closet system," which has been pronounced a way of laying on sewer-gas into every household. This is a very serious charge, but it appears to be built upon facts carefully observed in various places. Very few water-closets are constructed in the best known manner, and even when the builder has tried the unusual experiment of honest work the fact remains that a water-joint is no absolute barrier to the interchange of gases.

A paper by Dr. A. Key, of Montrose, conveys a grave warning how even intelligent efforts to place and maintain a house in a good sanitary condition may be baffled. Eight severe cases of diphtheria occurred in a farmhouse near that town. The house was built on a rising ground facing the sea, and the drainage was faultless. The water for drinking, cooking, &c., was obtained from a well near the sea, the water of which had been submitted to analysis and pronounced pure. There was no water-closet in the house, and the privy at the bottom of the garden was clean. Yet previous to the attack of diphtheria there had been, during twenty years' occupation of the farm, seven outbreaks of typhoid fever. Dr. Key at last noticed a pond which served to contain water for the threshing-mill, and which was offensive. A pipe had been unfortunately carried from this pond into the kitchen, to supply water for washing, &c., though the servants had been strictly charged never to use it for drinking or cooking. The cook, however, confessed that, to save trouble, she had often used this infected water for making soup, &c.! *Hinc illæ lachrymæ.*

Other cases mentioned in the book before us all teach the same lesson.

Year-book of Pharmacy; comprising Abstracts of Papers relating to Pharmacy, Materica Medica, and Chemistry, contributed to British and Foreign Journals, July 1st, 1881, to June 30, 1882, with the Transactions of the British Pharmaceutical Conference at the Nineteenth Annual Meeting, held at Southampton, August, 1882. London: J. and A. Churchill.

THIS volume opens with a general survey of the progress of pharmacy, and of such departments of chemistry as are most closely connected therewith, during the past year, especial attention being paid to the organic bases.

In the section on chemistry we note the remark that "the artificial production of indigo may even now be said to be within measurable distance of commercial success." This statement scarcely agrees with the recent admissions of Prof. Baeyer, as given by the *Chemiker Zeitung*.

Under the head "Materia Medica and Pharmacy" we find it mentioned that the importation of Indian opium into China is being considerably reduced, not from any decrease in the consumption, but in consequence of the extending use of native-grown opium and of that derived from Persia.

Some of the paragraphs placed under "Pharmacy," *e.g.*, that on "Ericine," the alleged yellow dye obtained from heath, might have figured quite as suitably under the section on "Chemistry."

In the Presidential Address, delivered at the Conference, attention is called to the wide sale of secret and proprietary medicines, distributed by persons who have often no knowledge of drugs, and who in some cases are not even legally responsible for the harm that may be caused by their use. At a subsequent meeting, Dr. Symes having read an interesting paper on certain Brazilian drugs, Mr. Groves "asked if Dr. Symes had experimented with these drugs on any of the lower animals; but he presumed he would require a license before operating even on a mouse. It appeared to him a great obstacle to science that a simple matter like this, which Dr. Symes had been kind enough to bring forward, could not be dealt with satisfactorily in consequence of the action of the anti-vivisectionists. A dose of this medicine could not be given to a mouse, although it might do the mouse good, in consequence of the existence of the Act of Parliament!"

Prof. Redwood, in commenting upon a notice of some advanced sheets of the new American Pharmacopœia, remarked that in receipts and formulæ "parts by weight" were preferable to any system of weights, traditional or metric.

The Brewer, Distiller, and Wine Manufacturer. By JOHN GARDNER, F.I.C., F.C.S. London: J. and A. Churchill.

THIS work is one of "Churchill's Technological Handbooks," and appears to have grown out of "Cooley's Cyclopædia of Practical Receipts and Collateral Information in the Arts, Manufactures, Professions, and Trades." The publishers remark in their announcement that some persons are unwilling to purchase an Encyclopædia when they only desire to consult a limited portion of it, whilst others seek for fuller information than could be afforded in a work of such scope. The name of Mr. Gardner does not appear, indeed, on the title-page, but as he appends his signature to the "Editor's Preface," he must be practically regarded as the author.

The first chapter of the work is devoted to "Alcohol and Alcoholometry." The editor treats of the preparation of absolute alcohol and of hydrated or commercial alcohol, using ordinary "spirit of wine" as a starting-point. Mention is also made of the synthetic production of alcohol by the action of olefiant gas upon sulphuric acid as effected by Henel and Berthelot, and from the treatment of acetyl chloride with glacial acetic acid in presence of sodium amalgam (Saytzeff and Linnemann).

Jullien's process for obtaining alcohol from madder-root can scarcely now lay claim to practical importance, since the cultivation of madder appears to be approaching its end. Prior to the introduction of artificial alizarin it may have been of value.

The chemical properties of alcohol, the methods for discovering impurities present, and for its recognition in toxicological cases are next given. The instructions laid down for the last-mentioned purpose are too brief to be of value to anyone not already conversant with such operations. The author remarks that "the use of methylated spirit in the preparation of tinctures, sweet spirits of nitre, ether, or any medicine for internal use is prohibited by law." Yet it is well known that such methylated alcohol is employed for medicinal uses, and Mr. H. B. Hewetson (*Lancet*, July 1) maintains that the ether from methylated spirit is safer and more efficient for the production of anæsthesia than the ether from a pure alcohol.

The subject of alcoholometry is dealt with at very considerable length.

In the chapter on beer and its materials we read—"A malting at the present time is but the counterpart of what it was fifty years ago. This is the more astonishing, since malsters were never tired of inveighing against the malt-tax when it was in existence, and urging the many improvements which were possible if it were only removed." Perhaps if malt were the only material from which beer might be legally made these improvements might have been carried into effect. But we believe the English malster has found the effects of the repeal of the malt-tax somewhat different from what he anticipated.

Under cider we find mention of the unpleasant fact that much of what is sent to London contains a dose of alum.

Under "Liqueurs and Cordials" there is mention of the manufacture of absinthe. Sulphuric acid, and "another very dangerous ingredient," *i.e.*, antimony, are said to be occasionally introduced. We doubt, however, whether either of these sophistications can be more dangerous than the oil of wormwood itself. We are surprised that none of our temperance reformers demand the total prohibition of its importation into or sale in Britain—a step which would be sound policy.

In the chapter on the "Distillation of Alcoholic Liquors" we are told—"In France, Germany, and Denmark, large quantities of spirits of good quality are manufactured from potatoes." Concerning the quality of potato-spirit some doubt may be entertained. It is so rich in amylic alcohol that in some parts of North Germany, Poland, &c., it is familiarly spoken of as "fusel." It is interesting to see the Polish peasant gulp down this spirit with a shudder provoked by its nauseous flavour, the only inducement being its great intoxicating power. Beet-root spirit, as the author mentions, is also rich in fusel-oil.

In the chapter on "Wine and Wine Making" we meet with a doubtful statement—"The vine thrives best in a warm loose soil composed of argillaceous marl, lime, chalk, and gypsum, pervious to air and water." We have always been accustomed to regard the vine as a potash plant, affecting volcanic soils and such as result from the decomposition of felspar, as in the Greek Islands, Southern Italy, the Rhine, &c.

We are glad to find that Mr. Gardner denounces the evil practice of "plastering" wines. This industrial sin could be easily suppressed, as far as the United Kingdom is concerned, were it enacted that all wines containing more sulphuric acid than the proportion naturally present in the juice of the grape should be destroyed.

The work before us may upon the whole be pronounced to be accurately and carefully compiled, and likely to prove of great service to the very numerous persons interested in the wine, beer, and spirit trades.

Detection of Sodium Sulpho-rosanilate.—R. Kayser. Amylic alcohol extracts a colouring-matter the solution of which shows the spectrum of rosaniline.—*Zeitschrift.*

CORRESPONDENCE.

THE CLOSING OF BOTTLES.

To the Editor of the Chemical News.

Sir,—The remarks on the loss of volatile liquids from stoppered bottles (Chemical News, vol. xlvi., p. 286) induce me to ask you to publish, for the information of any chemists who have not tried the plan, the use of the caoutchouc caps sold at the india-rubber shops as coverings for the fingers of men using acid liquids, which are made of two sizes, called in trade "finger-stalls" and "thumb-stalls," being of the sizes to go on the forefinger and thumb of a working man. I constantly use these as caps for bottles for any liquids or gases which do not act on caoutchouc. They press closely on the neck of the bottle, and can be drawn off at once when it is to be opened; or they can be made very tight by wiring if it is to be kept long closed.—I am, &c.

Henry B. Gibbins.

Neath, January 18, 1883.

RUBERINE.

To the Editor of the Chemical News.

Sir,—In reference to my letter in the Chemical News (vol. xlvii., p. 23), the Editor of the *Journal of the Chemical Society* has pointed out to me that the inaccuracies complained of were purely printer's errors and not due to any omission in the MS. of the abstractor, which I have seen and is perfectly correct.—I am, &c.,

T. L. Phipson.

London, January 23, 1883.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

Sir,—In an article which appeared in the Chemical News (vol. xlvi., p. 283), Lieut.-Col. Ross has so completely misquoted a passage from my "Manual of Blowpipe Analysis" that I feel constrained to correct him.

After giving, in his own way, my description of a well-known qualitative test, which he wrongly regards as long and complicated, he closes by representing me as stating to the student that he "will not find it easy to follow accurately the above changes in the appearance of the melted button of arsenides, especially if it is small." What I actually wrote was this:—"The beginner will not find it easy to follow accurately the above changes in the appearance of the melted button of arsenides, especially if it is small, but the progress of the operation can always be easily followed if," &c.

By omitting the end of my sentence the Lieut.-Colonel has made me appear to state the exact opposite of what I did state, and to that I object, even when it is done in support of a system of Pyrology. I may add that until yesterday I was unaware of the existence of his "little manual, published in 1880," although I have examined his earlier work.—I am, &c.,

H. B. Cornwall.

John C. Green School of Science, College of New Jersey, Princeton, January 6, 1883.

A CORRECTION.

To the Editor of the Chemical News.

Sir,—Will you allow us to call attention to certain inaccuracies and omissions in the paper presented by us to the French Academy of Sciences, an abstract of which appeared in the Chemical News, vol. xlv., p. 251. The formula of mellogene is incorrectly given (doubtless through a printer's error) as $C_{14}H_2O_4$ instead of $C_{11}H_2O_4$. We find no allusion to our experiments on graphitic acid, which we obtained in abundance by electrolysis, using an acid solution with an electrode of graphite.

We would also wish to take the present opportunity of referring to an abstract published in the Chemical News, vol. xlvi., p. 25, of a paper by Dr. Tommasi, in which he makes special allusion to our investigations. In the paper presented by us to the French Academy of Sciences we made no claim of priority as one would be led to believe in reading the last lines of the abstract inserted in your journal. We limited ourselves to a simple description of our researches into the various combinations exhibited by oxygen and carbon under electrolysis. In a note which accompanied our paper to the French Academy we expressed surprise that Dr. Tommasi, in his communication to *Comptes Rendus*, p. 790, 1882, should have called attention, with an almost prophetical air, to the combinations which might occur between oxygen and carbon when subjected to the electric current, whilst he was at that very time aware of our researches.

As regards our discovery of the various compounds and combinations alluded to in our paper, it was unnecessary for us to claim any priority in that respect, seeing that such priority had never been disputed.

Notwithstanding what we have above written, we may further add that Dr. Tommasi, in the *Revista Scientifico-Industriale*, and in the *Orosi*, a chemical and pharmaceutical journal, both of Feb. 21, 1881 (but *not* in the *Nuovo Cimento*, as he would lead us to believe by his communication to the Chemical News), writes as follows:—"Far from me any intention of claiming by my present note any right of priority in the investigations, &c.," and if you will have the goodness to refer to *Comptes Rendus*, May 29, 1882, No. 22, you will find that Dr. Tommasi writes—"A propos d'une reclamation on pouvait dire *observation* faite par MM. Bartoli et Papasogli au sujet du note precedente qu'il na pas eu l'intention de contester leurs droits de priorité."

We shall feel much obliged by your publishing the above remarks, which are of importance in their bearing upon the mellogene formula, whilst they will also set at rest all doubts as to priority in the discovery, and which would never have arisen had it not been for the abstract of the paper by Dr. Tommasi published in your journal.—We are, &c.,

Dr. G. Papasogli.
Dr. A. Bartoli.

Instituto Tecnico-Florence.
January 9, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 11, December 5, 1882.

Russian Chemical Society.—Session of April 1/13.—M. Butlerow presented a communication on the oxidation of iso-dibutylene by potassium hypermanganate, and a note on atomic weights. In view of the anomalous results obtained by M. Schützenberger with the carbides of the petroleums of the Caucasus, benzine and aniline—results which may be explained by admitting the variability of atomic weights,—M. Butlerow thought it necessary to explain the manner in which he regarded this hypothesis. He described the experiments which he had undertaken in conjunction with M. Rizza on the atomic weight of chlorine after isolation, and of chlorine kept in the dark. He has sent a note on this question to the Chemical Society of Paris.

Determination of Salicylic Acid in Milk and Butter.—A. Rémont.—The author agitates 20 c.c. of the milk with 2 or 3 drops of sulphuric acid in a test-tube. The agitation should be strong enough to break up the clot and form a homogeneous mixture; 20 c.c. of ether are poured in, gradually at first, and the whole is shaken up until the ether is emulsified only in part. After standing, 10 c.c. of the ethereal solution are decanted into an ordinary test-tube having a mark corresponding to a volume of 10 c.c. The ether evaporates, leaving a residue of butter, which is boiled with 10 c.c. of alcohol at 40 per cent, and is then allowed to cool. We have thus 10 c.c. of solution containing all the salicylic acid of an equal volume of milk. It is poured upon a filter, and 5 c.c. are received in a graduated tube of 0·015 metre in diameter; 2 or 3 drops of ferric chloride (diluted with 100 parts of water) are added, and the intensity of the violet colour obtained is compared with that of an analogous liquid prepared from pure milk to which known proportions of sodium salicylate have been added. Butter is examined in a corresponding manner.

Nitrogen Selenide.—M. Verneuil.—The author mixes up 10 grms. selenium perchloride with a few drops of carbon dichloride, and the paste obtained is suspended in a litre of the same solvent. A current of dry ammoniacal gas is directed into the liquid; flakes of ammonium chloride are precipitated, and the liquid gradually takes a decided rose colour. It is well to agitate the liquid frequently. The red colour gradually disappears, and there are deposited brown flocks, a mixture of ammonium chloride and probably of a compound of selenium, and nitrogen selenide. The current of ammoniacal gas is continued until these flocks turn to a fine light orange. The whole is then filtered, washed with carbon disulphide, the mass pressed in linen, and the product dried in a current of air. The orange powder obtained is a mixture of ammonium chloride and nitrogen selenide. The former body is removed by washing in water, and the product, after drying in the air, is finally purified with boiling carbon disulphide. The composition of the selenide is expressed by Se_2N. It is a light orange amorphous powder, insoluble in water, ether, and alcohol, very slightly soluble in carbon disulphide, benzol, and glacial acetic acid. When dry, it detonates if struck with a hard body, and explodes if heated to 230°. It is decomposed by potassa, whilst the liquid retains potassium selenite and selenide, and all the nitrogen escapes as ammonia. It is slowly decomposed by boiling water.

No. 12, December 20, 1882.

Russian Chemical Society.—Session of April 29/May 11, 1882.—M. Wroblewsky announced that symmetrical nitroxylene is transformed by oxidation into nitro-iso-phthalic acid. He also gave certain experimental data confirming the formula of benzol as proposed by M. Ladenburg.

M. Sokoloff presented, on behalf of M. Gué, a communication on the nitric ethers of lactose.

M. Menschoutkine gave an account of his researches on the formation and decomposition of acetanilide.

M. Jawein, on behalf of M. Wilm announced that amongst the metals of the platinum group, as obtained by reduction by means of hydrogen from their ammoniacal compounds, or the double salts which they form with ammonium chloride, platinum is the only one (except osmium and ruthenium) which does not become oxidised when heated to bright redness in a current of air. The other metals readily absorb oxygen, forming lower oxides. Thus a given weight of pure palladium gained 6·68 per cent. If the heating of the metal is continued, the increase of weight ceases as soon as the palladium is converted into a homogeneous deep grey mass, corresponding to the sub-oxide Pd_2O, and containing 6·99 per cent of oxygen. The oxidised metal may be reduced at the ordinary temperature by a current of hydrogen. Under the same conditions metallic rhodium absorbs 12·96 per cent of oxygen, forming a black sub-oxide, RO, containing theoretically 13·29 per cent of oxygen. Iridium reduced from the pure iridium-ammonium chloride absorbs 4·55 per cent of oxygen. The formula IrO would require 7·47 per cent, and Ir_2O only 3·88 per cent. The value found seems to refer to an intermediate oxide, $Ir_2O + IrO$.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 12.

The Influence of the Structure of the Soil upon its Thermometric and Hygroscopic Relations.—Prof. E. Wollny.—The author distinguishes a powdery and a crumbly condition of soils, the former state occurring in land which has never been under cultivation, or has been left to itself for a number of years, or has to be frequently dug over. The crumbly soil is such as is in a state of normal cultivation. As regards the moisture in the soil he concludes that the proportion of water in a soil and the degree of evaporation from its surface increase directly as the fineness of the particles. During the warm portion of the year the soil is warmer the coarser it is. At or below freezing-point the reverse holds good. A coarse soil, however, thaws more rapidly, and is more readily warmed in spring.

Agricultural Use of the Slag obtained in the Basic Dephosphorising Process.—Such slag on analysis was found to contain 19 per cent of phosphoric acid. It cannot be advantageously rendered soluble with sulphuric acid, as it quickly "goes back." A large part of the phosphoric acid originally present is soluble in ammonium citrate, and may hence be considered as available for plant food. As the presence of large quantities of ferrous and manganous salts may make its direct application to the crops unsafe, the author recommends that it should be spread early in autumn on fields which are to be sown in spring. Or it may be scattered over dung heaps.

Experiments on Sugar-Cane with Artificial Manure.—E. Riffard.—From the *Revue des Industries.*

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 3, 1882.

New Method for Determining the Ignition-Point of Petroleum.—Leo Liebermann.—This paper requires the accompanying figures.

Ignition-Point of Petroleum Admissible in Practice.—Leo Liebermann.—From a study of the maximum temperatures naturally occurring, the author concludes a petroleum, the flashing-point of which exceeds 60°, may be safely used in all parts of Europe.

A New Metnod for Determining the Sulphur in Coal-Gas.—Dr. O. Knublauch.—This important paper cannot be reproduced without the accompanying figure.

Determination of Phosphoric Acid by the Molybdic Method.—Drs. Stünkel and Wetzke and Prof. Wagner.—This paper is reserved for insertion in full.

The Action of Potassium Dichromate upon Potassium Iodide, and the Alkalinity of Alkaline Dichromates.—M. Richter.—The author has discovered that potassium dichromate and iodide if dissolved in water react in such a manner that potassium monochromate is formed, whilst free iodine is separated out. If the solutions of both salts are concentrated the iodine is deposited in crystals. The author endeavoured to found upon this reaction a volumetric method for the determination of potassium dichromate, estimating the liberated iodine in the known manner by means of a solution of sodium hyposulphite, and then finding by calculation the corresponding quantity of potassium dichromate. He soon reached the view that the decomposition is only partial, and that a considerable time is required for the complete conversion of the dichromate into the mono-

chromate, and abandoned the process, but returned to it again in consequence of the researches of E. Donath (*Zeitschrift Anal. Chemie*, xviii., p. 78). The latter chemist maintains that the separation of iodine is due to the presence of free chromic acid. M. Richter has therefore repeated his experiments with dichromate free from free chromic acid, and with potassium iodide containing neither potassium iodate nor free iodine, but obtained the same results as before. For greater certainty the experiment was performed in an atmosphere of hydrogen, and the water used had been freed from dissolved oxygen by repeated boiling. The reaction may be employed for detecting dichromates present in monochromates, especially if potassium iodate is added along with the potassium iodide. Mohr has investigated the same reaction (*Zeit. Anal. Chemie*, xi., p. 278), but, like Donath, concludes that no iodine is set free, and cites this reaction in support of his opinion that the dichromate is not an acid, but a neutral salt. M. Richter, on the other hand, has succeeded in showing by means of phenol-phthaleine that the monochromate possesses no basic properties, and must be regarded as the neutral salt.

Decomposition of Nitrous Oxide and of a Mixture of Nitrous Oxide and Nitric Oxide at a Red Heat. A. Wagner.—The author examined if nitrous oxide can be determined by means of its oxidising action upon an ignited mixture of chromium sesquioxide and sodium carbonate in the absence of air, and was completely successful. The nitrous oxide decomposed can be determined either by the volume of the nitrogen liberated or by the quantity of sodium chromate formed, since 1 vol. nitrous oxide yields 1 vol. nitrogen, and 1 part chromium oxide requires 0·3136 oxygen for conversion into chromic acid. The author found by especial experiments that by heat alone, in the absence of the mixture of sodium carbonate and chromium sesquioxide, only 28·2 per cent of the nitrous oxide is decomposed. A mixture of equal vols. nitrous and nitric oxide is entirely decomposed under the same conditions, giving up all its oxygen, whilst any excess of nitric oxide escaped unchanged.

Volumetric Determination of Ferrous Oxide in Hydrochloric Solution by Means of Potassium Permanganate, and the Question of Chemical Induction in General.—Fr. Kessler.—The author points out that the experimental results of Clemens Zimmermann (*Zeit. Anal. Chemie*, xxi., p. 108) have been anticipated by his own researches published in *Poggendorff's Annalen* (cxviii., p. 48, and cxix., p. 225). This phenomenon, along with many analogous facts, the author explains by the general principle that mutually indifferent bodies existing in solution together may be rendered active by transformations taking place in the same liquid. This process, following the example of Bunsen, he calls "chemical induction." Thus the oxygen dissolved in water, tolerably inactive as regards stannous chloride, is rendered active if this salt of course in hydrochloric solution, is converted into stannic chloride by means of permanganate or chromic acid. The author mentions the paradoxical case that chromic acid may act as a reducing agent. If a few grammes potassium antimony tartrate are dissolved in water, and hydrochloric acid added to prevent turbidity, ferric chloride and potassium ferricyanide if present do not react upon each other. But if a few c.c. of chromic acid be added the liquid turns blue.

Testing Butter.—Dr. J. Munier.—The author criticises the original process of Hehner, and the modification proposed by Reichert (*Zeit. Anal. Chemie*, xviii., p. 68), which he finds untrustworthy. From a series of analyses carried on during an entire year it appears that the proportion of volatile acids fluctuates with the season, and is lowest in October, November, December, and January. In February there was a sudden and well-marked increase of the fatty acids, which continues till August, and then gradually declines. Hence different limits must be established for the different seasons.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Vitriol Chamber.—A subscriber wishes to know the proportions of a chamber necessary to make 650 lbs. of 66° Baumé sulphuric acid per diem from Italian sulphur, where there are seven months cold weather, three temperate, and two hot?—SUBSCRIBER.

Precipitation of Carbonate of Lime from Water.—Some time ago I saw it stated in a report by Dr. Angus Smith on the water around Manchester that caustic soda would precipitate carbonate of lime from water. Having reason to doubt this, I made strong solution of carbonate of lime in water by means of carbonic acid gas, and afterwards added some solution of NaHO, but failed to get a precipitate. I also tried the effect of adding NaHO to a water containing carbonates and sulphates of lime in equal proportions, and got a precipitate of the sulphate, but it did not touch the carbonate. Dr. Smith also states that if NaHO be added to a water containing $CaCO_3$ and $CaSO_4$, the NaHO will combine with the CO_2 which holds the $CaCO_3$ in solution, forming Na_2CO_3, which in turn will act on the $CaSO_4$ and cause a precipitate of $CaCO_3$, leaving Na_2SO_4 in solution. Would any of your contributors kindly state if this is the case, as I have tried the experiment and do not get these results.—W. G.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 29.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field, F.C.S.
TUESDAY, 30th.—Royal Institution, 3. "Primæval Ancestors of Existing Vegetation," by Professor W. C. Williamson.
— Institution of Civil Engineers, 8.
— Society of Arts, 8. "Life among the Turkoman Nomads," by Edmond O'Donovan.
WEDNESDAY, 31st.—Society of Arts, 8. "Ensilage in the United States," by Prof. Thorold Rogers.
THURSDAY, Feb. 1st.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
— London Institution, 7.
— Royal, 4.30.
— Chemical, 8. Ballot for the Election of Fellows. "Some Derivatives of Fluorene," by W. R. E. Hodgkinson, Ph.D., and F. E. Matthews, Ph.D.
FRIDAY, 2nd.—Royal Institution, 8. "The Size of Atoms," by Sir William Thomson, at 9.
— Geologists' Association, 7 30. (Anniversary).
SATURDAY, 3rd.—Royal Institution, 3. "Sir John Lawrence and the Mutiny, 1857," by Mr. R. Bosworth Smith.

TO CORRESPONDENTS.

W. G.—To give the tables referred to would nearly fill a number of the CHEMICAL NEWS.

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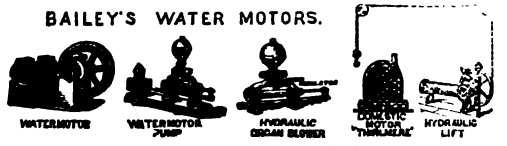

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1210.

MODIFICATION OF ONE OF THE PROCESSES FOR THE ESTIMATION OF THE AVAILABLE CHLORINE IN BLEACHING-POWDER.

By J. W. CHALMERS HARVEY.

ONE of the methods which Fresenius recommends for the expeditious estimation of the available chlorine in bleaching-powder consists in dissolving a weighed quantity of iron wire in hydrochloric acid, diluting the solution of ferrous chloride thus obtained up to about 200 c.c. with water, and determing in the number of c.c. of the bleaching-powder solution which is required to convert the ferrous into ferric chloride.

The equation is $2FeCl_2+2Cl=Fe_2Cl_6$.

The bleaching solution is prepared by making 10 grms. of the bleaching-powder into a thin paste with water in a porcelain mortar, adding more water, transferring to a litre flask, and making up to this measure. 1 c.c. = 0·01 bleaching-powder.

The modification of this process which I propose does away with the necessity of weighing out a certain quantity of iron and dissolving to ferrous chloride. The basis of this method consists in adding a measured quantity of a dilute solution of stannous chloride to a solution of ferric chloride; this latter must be in excess.

The reaction is $Fe_2Cl_6+SnCl_2=2FeCl_2+SnCl_4$.

The iron converted into the ferrous condition is then estimated by a standard solution of potassium bichromate. A known amount of ferrous chloride can thus be formed immediately.

Conduct of Process.—Add the same measured quantity of stannous chloride as in the standard experiment to an excess of a solution of ferric chloride. Dilute this solution up to about 150 c.c. with distilled water and titrate with the solution of bleaching-powder (previously well shaken) until a drop taken out ceases to give a blue or bluish-green colour with potassic ferricyanide. The amount of chlorine which the ferrous chloride formed by the stannous chloride will require for its conversion into ferric chloride is found by the following calculation.

Suppose the iron found by the bichromate, and corresponding to the stannous chlorine added, to be 0·20 grm., then—

Fe Cl Fe
112 : 71 :: 0·2 = x = 0·01268 Cl.

Suppose, further, that 47 c c. bleaching-powder solution have been used to oxidise this amount of iron, then they must have contained the above quantity of chlorine; then as each c.c. = 0·01 bleaching-powder—

C.c. Grms. B.P. Cl B.P. Chlorine.
47 = 0·47; then if 0·47 : 0·01268 :: 100 : x = 26·97 p.c.

The following are the results of some experiments executed in this manner compared with others attained by dissolving iron in hydrochloric acid in the usual way.

Usual way.	Modification.
27·47	27·45
27·43	27·42
—	27·45

The requisites for the foregoing modification are:—

1. Solution of stannous chloride.—This is prepared by dissolving 60 grms. in HCl with the aid of heat and making up to 1 litre. 5 c.c. of this solution are sufficient for each experiment. The amount of ferrous chloride to which it corresponds should be determined before each series of assays, as stannous chloride is very prone to change.

2. Solution of ferric chloride.—This must be absolutely free from ferrous chloride, and may be made by dissolving red hæmatite (as pure as obtainable) in hydrochloric acid, or iron wire in the same acid, oxidising this latter with potassic chlorate, and evaporating off excess of chlorine.

3. Standard bichromate.—Dissolve 30 grms. in hot water, cool, and make up to 2 litres, 1 c.c. = 0·017 grm. iron.

Maryport, Cumberland, Jan. 22, 1883.

PRESENCE OF TELLURIUM IN COPPER.*

By T. EGLESTON, Ph.D., New York City.

SOME months ago, samples of black oxide of copper and of pig-copper from Colorado were sent to me to examine for arsenic and antimony. I examined them both by the blowpipe and in the wet way, but found none present. A quantity of this material was purchased by a large metallurgical works; but when they attempted to refine it, they pronounced it to be full of arsenic and antimony; so much so, that their furnaces were, as they said, "poisoned," and rendered unfit for refining. I then re-examined the samples, and at the same time some of the material which had "poisoned" the furnaces, and found no traces of arsenic or antimony when the usual amounts for analysis were used; but on taking very large amounts I found traces merely, in some parts of the sample, but not in all. As it was a matter of interest to ascertain what the white substance that "poisoned" the furnace was, I sent to the works making the black copper, and obtained some of the matte from which the black copper was made. I took careful samples both of it and the black copper and the refined copper. I then found the impurity to be tellurium, a substance not heretofore known as occurring in copper. I give below one analysis of the matte, two of the black, and one of the refined copper:—

	Matte.	Black copper.		Refined copper.
Copper	55·02	97·120	98·090	99·705
Gold	0·06	—	—	—
Silver	0·40	0·132	0·128	0·135
Lead	17·87	0·777	0·757	none
Zinc and nickel	2·22	0·070	0·100	0·024
Iron	4·18	0·130	0·080	0·031
Sulphur	20·02	0·236	†	trace
Tellurium	0·12	0·093	0·097	0·083
Arsenic	†	0·006	†	0·091
Slag, &c.	—	1·270	0·192	—
	99·89	99·834	99·444	100·069

The mattes and the black copper are results of the treatment of copper ores with the tellurium ores of Colorado. In the laboratory, no traces of white fumes were shown on charcoal; but when the metal in the furnace was subjected to the process of "dry roasting," as was unintentionally done, very dense white fumes were given off. When refined and cast into cake, it had the ordinary appearance of cake copper. It was then re-heated for rolling in the ordinary way, showing no signs of impurity. At the first pass in the rolls, very fine cracks showed themselves, which opened in succeeding passes. At a thickness of about 0·03 metre, the cracks on each side nearly penetrated the cake, and at about 0·008 metre it began to fall to pieces. It was heated and rolled at different temperatures, but always with the same result. When cold, the metal is tough and malleable. Although

* A Paper read at the Harrisburg Meeting of the American Institute of Mining Engineers.

† No traces were found with the blowpipe.

the cakes in the moulds showed no coating, when they were heated repeatedly and allowed to cool in the air they became covered with a white powder, which proved to be the oxide of tellurium. The copper, as it comes from the cake-moulds, has every appearance of being good copper.

This is the first time, so far as I know, that the presence of tellurium has been detected in commercial copper. But very little of it is removed in the treatment, as the four analyses show. It is surprising how very small a quantity renders the copper red-short, and consequently worthless for rolling.

ON BISULPHIDE OF CARBON.

By L. H. FRIEDBURG, Ph.D.

Several years ago I published some notes on bisulphide of carbon (*Berichte d. Deut. Chem. Gesell.*, viii., 1616), to which I shall now add a few more observations. Then and there I showed how to clean the bisulphide by means of fuming nitric acid, and that the vapours of nitrous acid, of nitrogen dioxide, of sulphurous acid, &c., were taken up and invariably retained by the bisulphide. Dry bisulphide of carbon serves as a very good conveyance for the reaction of such gases and vapours in a dry state on each other and on other substances. The only disagreeable feature in this regard is that carbon disulphide in most cases also enters the reaction, forming very undesirable products and sometimes only such sulphur containing products are formed in any notable quantity. The following reactions are the only three I wish to mention, as they may prove germs for further investigations.

1. Bisulphide of carbon charged with the vapours of nitrogen dioxide and then mixed with pure benzol, forms amongst other products large broad crystals of dinitro-benzol, melting at +86° C. These crystals are formed after standing a considerable time, and after the partial evaporation of the mixed liquids at summer heat.

2. I think that great interest is attached to the reaction of the afore-mentioned liquids in direct sunlight. The brown vapours begin to disappear without escaping from the narrow neck of the very large flask, in which such experiments take place, and in proportion as they disappear, small white crystals begin to cover the sides of the flask within. This covering principally takes place above the edge of the liquid on the bare glass. The crystals could not be analysed, because they decomposed when brought in contact with air, yielding then NO_2 and benzol. It is not entirely out of the way to suppose that in this case addition-products formed, analogous to benzol-hexachloride = $C_6H_6Cl_6$, so that the white crystals in this case might be either $C_6H_6(NO_2)_4$ or $C_6H_6(NO_2)_6$, which of course needs further investigation.

3. A very pretty reaction takes place when bisulphide of carbon charged with dry sulphurous acid gas, and the same medium charged with nitrogen dioxide (which was not free from nitrous acid) are brought together. This reaction might be used as a lecture experiment. Keeping the vessels cool and dry (I generally use a spacious beaker), white crystals very readily form in considerable quantity, which, in fact, are nothing but lead chamber crystals. This reaction treated analytically may some day throw new light on the formation and composition of lead chamber crystals.

The bisulphide of carbon cleaned by means of fuming nitric acid is the only chemically pure I came across, and I therefore proceeded to determine its specific gravity as well as boiling-point, without finding, though, any differences from any former determinations.

The specific gravity at + 15·2° C. is 1·266, and the boiling-point +47·4° C., at 0·760 m. pressure.

The pure bisulphide shows materially no other so-called physical properties than those known heretofore.

Finally, I want to state that in treating raw bisulphide of carbon, coming from the retorts of manufacture, with fuming nitric acid, I could invariably detect mono-nitro-benzol in the residue of evaporation, which leads me to believe that amongst the numerous products formed in the red-hot retorts, particularly if the charcoal was not dry enough, there is also benzol.

2. The purifying influence of a non-coloured and inodorous fat, for instance, such as the oil of African palm kernels, good as it is for the bisulphide of carbon, becomes a nuisance when this latter is used as a means of extraction of the former. I advise, therefore, from long experience, all those who extract fats (particularly if it is for manufacturing) by means of CS_2 never to use an excess of this latter, and never to let a new mixture of oil and bisulphide run into the still in which oil already freed from bisulphide is retained. This latter will else be rendered impure.—*Journal of the American Chemical Society*, November, 1882.

ON THE CONSTITUTION OF THE SUBSTITUTED ACRYLIC AND PROPIONIC ACIDS.

By HENRY B. HILL.

Within a few years the number of substituted acrylic and propionic acids known has been largely increased, and yet the constitution of but few of these can be said to be satisfactorily established. In a previous communication I was led to adopt provisionally for mucobromic acid the formula—

$$\begin{array}{l} CBr_2\text{—}CHO \\ \quad | \\ =C\text{—}COOH \end{array}$$

which explained its connection with maleic acid, in whose molecule the researches of Fittig had shown the probable existence of a dyad carbon atom. The structure of the related dibromacrylic acid was then naturally expressed by the formula—

$$\begin{array}{l} CBr_2H \\ \quad | \\ C= \\ \quad | \\ COOH \end{array}$$

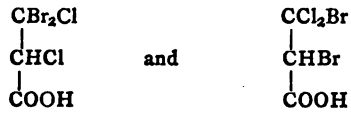
against which at the time nothing more convincing than a belief in its improbability could be urged. The relations which Andrews and I have shown to exist between this same acid and two different tribrompropionic acids prove, however, that this formula is incorrect. An acid with this structure could be formed from but a single tribrompropionic acid, and must of necessity give this same tribrompropionic acid by the addition of hydrobromic acid. The same objection also applies with equal force to the other two conceivable formulæ for dibromacrylic acid which contain dyad carbon—

$$\begin{array}{l} =CH \\ \quad | \\ CBr_2 \\ \quad | \\ COOH \end{array} \qquad \text{and} \qquad \begin{array}{l} =CBr \\ \quad | \\ CHBr \\ \quad | \\ COOH \end{array}$$

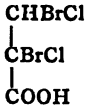
and these must consequently be rejected. There remain therefore for the acid in question but two possible formulæ—

$$\begin{array}{l} CBr_2 \\ \quad \| \\ CH \\ \quad | \\ COOH \end{array} \qquad \text{and} \qquad \begin{array}{l} CHBr \\ \quad \| \\ CBr \\ \quad | \\ COOH \end{array}$$

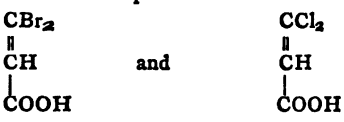
The formation of two isomeric dichlor-dibrompropionic acids by the addition of chlorine to the dibromacrylic acid and of bromine to the analogous dichloracrylic acid, as Mabery and I have shown, would seem again to be decisive in favour of the first of these formulæ, since its adoption would give—



as the structure of the two isomeric dichlor-dibrompropionic acids, while the second formula would give in either case the same compound—



Although it was by no means impossible that a molecular re-arrangement had taken place in one of these two reactions, still it seemed improbable, since the reactions were apparently neat, and in the treatment with chlorine, where such a change would be more naturally expected, no bromine could be detected in the escaping chlorine. On the other hand the adoption of the formulæ—

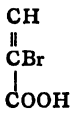


for the derivatives of mucobromic and mucochloric acids presented difficulties quite as serious. In the first place, the dichloracrylic acid of Wallach had been proved beyond all doubt to be different from that which Bennett and I had described by a comparison of the crystalline form of the two acids, and it would follow then that Wallach's acid could not have the formula he assigned to it. The formation of an acid with different structure from chloralid could, however, be explained upon the assumption that the chlor-propiolic acid was the first product of the reduction, and that this passed, on the one hand by the addition of hydrogen, into the β-chloracrylic acid, and on the other hand formed dichloracrylic acid by addition in the subsequent treatment with strong hydrochloric acid which Wallach prescribes.* Although this hypothesis was far from satisfactory, it seemed to me hardly more improbable than that a similar molecular rearrangement had taken place in the reaction which had come under my own observation.

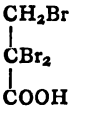
Still another difficulty was to be found in the formation of the dibromacrylic acid in question from the tribrompropionic acid melting at 92°, which, if the ordinarily accepted formula for the latter—

were correct, would prove the incorrectness of the formula assumed. I was at first unable to attach any great importance to this argument, inasmuch as the constitution of the monobromacrylic acids was extremely uncertain. For although the discovery by Wallach of the β-monobromacrylic acid melting at 115° had rendered the constitution of the α- and β-monobromacrylic acids of Tollens extremely doubtful, it by no means proved their identity.

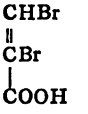
Erlenmeyer has, however, recently shown† that the α- and β-acids of Tollens, as well as their potassium salts, crystallise in identical forms, and the structure of the tribrompropionic acid melting at 92° is therefore put upon quite another footing. Since the same (a) monobromacrylic acids can be made from α-dibrompropionic and also from its isomer, the α-β-dibrompropionic, it follows that this acid must have the structure—



and the the tribrompropionic acid made from it by the addition of bromine must of course have the corresponding form—

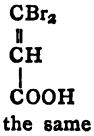


Since the formulæ with dyad carbon are in this case excluded, there remains for the dibromacrylic acid in question only the structure—



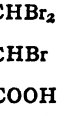
Although this conclusion is directly at variance with the results which Mabery and I obtained in the study of the dichlor-dibrompropionic acids, it must be confessed, I think, that it is probably correct. Still, since its adoption presents undoubted difficulties, I shall endeavour to bring more direct experimental evidence as to its correctness.

The dibromacrylic acid of Fittig and Petri, which, as Mabery and I have shown, can be made from brompropiolic acid, would naturally have the form—

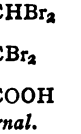


and the acids made in the same way containing two halogens the corresponding—

The tribrompropionic acid melting at 118° would be written—



and the tetrabrompropionic acid would have the form—



—*American Chemical Journal.*

Examination of Butter.—Th. Munzel.—The author heats exactly 1 grm. of pure butter fat with 12·5 grms. absolute alcohol in a test-tube till completely dissolved. The tube is then closed with a cork passing down almost to ths bottom. When the butter is dissolved, the outside of the test-tube is wiped, and the author, holding it loosely in his hand, notes the temperature at which congelation sets in. With pure butter this ensues at 34°, and in such containing 30 per cent of lard at 43°. Olœ-margarin from the Frankfort Company congeals at 56°.—*Zeitschrift.*

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* *Annalen der Chemie*, 193, 7.
† *Berichte der deutschen chemischen Gesellschaft*, 14, 1867.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, January 27th, 1883.

Prof. Clifton, President, in the Chair.

New Member—Mr. Hugh E. Harrison.

Prof. G. Carey Foster read a paper "*On the Determination of the Ohm*," in which he described the various methods which have been used and proposed in determining the B.A. unit of resistance. He also described a method of his own, proposed in 1874, and recently tried with good results. The method consists in balancing the E.M.F. set up in a coil of wire by spinning it in the earth's magnetic field, against the E.M.F. of a battery or other electromotor in a wire whose resistance is to be determined. The two opposing circuits through this wire, R, are composed, the first of the spinning coil and a zero galvanoscope, and the second of a battery and an absolute galvanometer, these two circuits meeting at the ends of the wire R. The late Mr. Hockin and Prof. Foster find that the best conditions obtain when the resistance of the absolute galvanometer, r, is equal to R; the resistance of the zero galvanoscope r_2 equal to $\frac{R}{2}+r_3$; and the resistance of the spinning coil r_3 many times the battery resistance, which should be so low as to be practically negligable. The E.M.F. of the battery should be double that of the spinning coil. Many other conditions had to be attended to, as explained by Prof. Foster. With this method, and using a thermo-electric battery giving an E.M.F. of 2·2 volts, the coil was spun at about 1800 revolutions per minute; r_1 was 63 ohms; r_2 was 135; r_3 was 50; and R was 73 in one and 80 in another experiment. R was made up of coils in a resistance box. The ohm was determined by two trials to be 1·003 and 0·999. This general result is so satisfactory that the experiments will be continued with extra precautions.

Mr. Glazebrook called attention to the remarkable agreement between the results of Lord Rayleigh's determinations and his own independent ones. Lord Rayleigh's figures are for the unit—0·9893, 0·9865, 0·9868, and Mr. Glazebrook's is 0·9866, or the mean of Lord Rayleigh's results. He also announced that the Clarendon Laboratory, Cambridge, would soon be in a position to test and certify any resistance coils sent there.

Mr. Walter Baily then read a paper "*On the Spectra formed by Curved Diffraction Gratings.*" In a diffraction grating ruled on a portion of a cylinder, if r is the distance of a point from the centre of the grating, and θ the angle which a line to the point makes with the perpendicular from the centre of the grating, c the radius of curvature of the grating, and d an arbitrary constant, a series of curves may be drawn in the plane perpendicular to the lines of the grating, having as the general equation—

$$r^{-1}\cos^2\theta = c^{-1}\cos\theta + d^{-1}$$

If a source of light is placed on a point on one of these curves, all the foci of the diffracted light lie on the same curve. The curve consists of two loops, one of which gives the spectra of transmitted, and the other those of refracted, light. When d is infinite these curves coincide in a circle, the properties of which have been used by Prof. Rowland in the construction of his diffraction spectroscope. The paper also described how the position of the spectra on the curves could be determined for any position of the source of light.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, December 28th, 1882.

Mr. B. S. Proctor, President, in the Chair.

The minutes of last meeting were read and confirmed.

Mr. H. A. Kay was elected a member of the Society.

The name of Mr. John Tilley, Goods Manager, North-Eastern Railway, North Shields, was read for the first time.

Dr. H. S. Pattinson and Mr. T. W. Hogg were elected as Scrutineers of the voting papers.

The evening was devoted to the exhibition and explanation of apparatus, &c, and the following notes and descriptions were read:—

Stearn's New Form of Illumination for the Microscope.—Exhibited by Mr. J. B. Payne, F.R.M.S.—Your kind attention is asked to a new adaptation of the electric light,—the illumination of microscopic objects by means of Swan's Incandescent Electric Lamp in place of oil or gas,—the origination and adaptation of which is due to Mr. C. H. Stearn, F.R.M.S. It is claimed for this new form of illumination that the trouble in cleaning and preparing the oil lamp, and the unpleasant heat and smell given off by it, is in this lamp entirely avoided; that the light is of purer quality; that the great ease and facility with which this lamp can be adjusted is beyond comparison with the ordinary oil or gas lamp, especially when it is required to change the position of the light to above or below the stage, as for opaque or transparent objects; and that condensers may, to a great extent, be dispensed with, thus also saving much trouble.

The lamp is calculated to give from one to three candle power, and is readily controlled by means of a small resistance coil of iron-wire interposed in the circuit.

The best form of battery is, undoubtedly, the Grove or Bunsen, two cells being generally sufficient, three ample.

When the lamp is used in special places, such as a drawing-room for instance, and the battery has to be placed in the same room, where the fumes from a Bunsen's battery would be objectionable, the Leclanché battery may be employed, or, better still, an accumulator. I have used a four-cell Leclanché battery, and also a modification of the bichromate battery with much success. Of course those persons who have adopted electric lighting for their residences, or laboratory, will only require to attach a connection to the supply, and will not need a battery.

In Mr. Stearn's microscope the lamp is permanently attached to, and made a portion of, the instrument, the body of the microscope forming one connection. Three lamps are fitted—one above the stage, revolving round its own axis; one below the stage, fitted on to the sub stage; and one fixed below the sub-stage, for use with the polariscope. Each lamp is connected to a three-way switch, enabling the operator to alter the position of the light with the greatest ease and freedom. But as I do not think everyone would like to go the expense of having this elaborate installation made, I have arranged fittings which can be used with the stand condenser, or simply fixed on to the stage by means of a clamp or a pin like that used with the stage forceps. By means of either of these fittings the little lamp can be easily and quickly transposed to any required position. In accordance with a promise given to Mr. Stearn, I am not permitted to do more than point out the principal features of this new form of microscope illumination, as he is anxious that I should not forestall a paper which he is to deliver in London next month.

Kühne's Model Eye for Demonstration Purposes.—Exhibited by Mr. C. E. Stuart, B.Sc., for Messrs. Brady and Martin.—This consists of a long rectangular trough which can be filled with water or other medium. The front end is provided with lenses and diaphragms of appropriate shape to represent the cornea and the crystalline

lens; hollow glass lenses are provided to receive the fluids serving as aqueous and vitreous humours, and a movable ground glass screen takes the place of the retina. With the help of movable lenses of various shapes, which stand in the trough, all the different pecularities and defects of vision, and the principles of the methods by which they are remedied, can be demonstrated to a class, perfect or defective vision being recognisable by clearness or blurring of the real images of external objects formed upon the ground glass plate.

Acid-resisting Bricks.—Exhibited by Mr. John Morrison.—It occurred to me a few days ago that a sample of the Welsh bricks, which are now beginning to be adopted in Lancashire and other chemical manufacturing centres, for resisting the action of acids and alkalies, might be of interest to this meeting; and my friend Mr. Gibson, of the Buckley Brick and Tile Company, has kindly, at my request, forwarded me the two blocks now on the table.

As most present are, I dare say, aware, Welsh fire-bricks are of two kinds, the blue or "C.S." and the white or "S.S." bricks, the former containing most alumina and iron, and the latter being the more expensive.

Until within the last three or four years Welsh bricks, so far as I am aware, were little, if at all, used for "Glover Towers," the pressed blue Staffordshire bricks being almost universally employed. The Buckley Brick and Tile Company, however, having found, after a number of experiments, that they could produce a dense and very slightly porous brick, which they believed could favourably compete with the Staffordshire brick, put up machinery for preparing them on a manufacturer's scale.

Some two years ago I was entrusted with the erection of sundry plant for the Connah's Quay Alkali Company, which included a pair of "Glover Towers"; but when the manager (Mr. Steedman) seemed inclined to try the Buckley bricks for their lining, I must confess I was at first very much opposed to what appeared to me to be a serious risk. After, however, carefully examining the process of manufacture, and after Mr. Steedman had boiled a brick for two months continuously in sulphuric acid, and found that no perceptible action had taken place, my prejudices began to give way, and the "metalline" bricks and blocks (as they are called) were finally adopted, not only for the lining, but for the arches of the towers.

I am glad to be able to say that up to the present time these towers are perfectly efficient, and that when, twelve months after their erection, an opportunity occurred of examining the arches, they were found to be, as Mr. Steedman expressed it, "as sound and perfect as on the day they were put in"; and, I have no doubt, they will last for eight years, if not even longer.

These bricks are now used also pretty extensively for revolver linings and "breakers," not merely in Lancashire, but in Yorkshire, Scotland, and Germany.

Revolver linings, 5½ inches thick, have lasted three to four years.

Large circled blocks have also been successfully employed for neutralising wells; but for that purpose, when Yorkshire flags are obtainable, I should hesitate about recommending them.

I fancy a good deal of their efficiency is consequent upon their non-porosity and almost absolute imperviousness to the internal action of alkalies or acids.

The absorptive power of bricks, even for water, varies very much, and in building bricks this is, in fact, the chief measure of their durability.

I remember, two or three years ago, immersing samples of the chief local brands of pressed fire-clay facing-bricks for twenty-four hours in water, and being rather surprised to find that, of the two best known and most expensive makes, one only absorbed 6 ounces of water, but the other no less than 13 ounces.

The metalline bricks are, I believe, prepared from mixtures of the best Welsh clays, according to the purpose for which they are designed. This mixture, after proper treatment, is introduced into a conical cylinder, and carried to the narrow end by means of a revolving screw. At this end the dies are fixed, and the clay is forced through them by means of an ordinary steam plunger. Each block is then simply pressed in a lever press, and after careful stove-drying is burnt in the ordinary manner.

The large sample on the table is from a quantity prepared for lining a round "Glover Tower," and the small one is, I believe, a revolver lining block.

The Combustion of Air in Coal-Gas.—A Lecture Experiment exhibited by Mr. J. T. Dunn, M.Sc.—There is nothing very new in this form of the apparatus, save that it is handier than most forms in use and does not require any reservoir of air.

It consists of an ordinary Argand chimney, mounted on a stand of convenient height. The upper end of the glass is covered by a cap of wire gauze, in the centre of which a hole of about 4 or 5 m.m. diameter has been punched. The lower end is fitted with a cork pierced with a hole in the centre, through which passes a glass tube, level with the cork beneath, and projecting 20 or 30 m.m. above its upper surface into the lamp-glass: this tube preferably ends in a wide jet of rolled platinum-foil. Two other holes in the cork, symmetrically placed on either side the centre, through which pass short tubes joined by a T-piece and india-rubber tube to the gas supply, serve to feed the apparatus with coal-gas.

The gas is turned on and lighted above the gauze. A narrow glass tube is pushed up through the open tube in the cork and through the hole in the middle of the gauze into the coal-gas flame. On gently blowing through this narrow tube (which for convenience should have a flexible india-rubber tube attached to it) the breath catches fire at the coal-gas flame, and the tube may then be gently withdrawn, when its little flame ignites the air entering the apparatus by the short open tube. The draught of the flame furnishes quite enough air to burn; and the apparatus, once lighted, will continue to act as long as the supply of coal-gas is kept up. The best air-flame is got by diminishing the gas supply to the lowest point consistent with the continued existence of the air-flame.

Groves's Apparatus for Nitrogen Determinations.—Exhibited by Mr. T. W. Hogg.—This apparatus, which is described in the *Journal of the Chemical Society* (1880, p. 500), consists of an inverted burette, graduated from the stopcock, and attached at its lower end by a flexible tube to a tube of similar dimensions open at both ends. The burette is likewise furnished, near the bottom, with a short side tube, which communicates, through a mercury valve, with the combustion-tube.

The apparatus is filled with caustic potash; the gases from the combustion-tube collect in the burette, the CO_2 being absorbed by the potash, and recession being guarded against by the mercury valve. After standing, the gas is brought to atmospheric pressure by raising or lowering the tubular reservoir, and the volume of the nitrogen read off.

Modification of Ramsbottom's Differential Gauge for Determining very slight Pressures of Gas, &c.—Exhibited by Mr. R. A. Lewis, M.I.M.E.—This apparatus is arranged on the principle of registering the difference of pressures on the two opposite sides, A and B, of the internal diaphragm, by a column of water counterbalanced by a fluid of a density slightly less than that of water—which fluid, however, must not be miscible with water, nor be affected by it.

In this apparatus benzol has been used, tinted red for the sake of distinction.

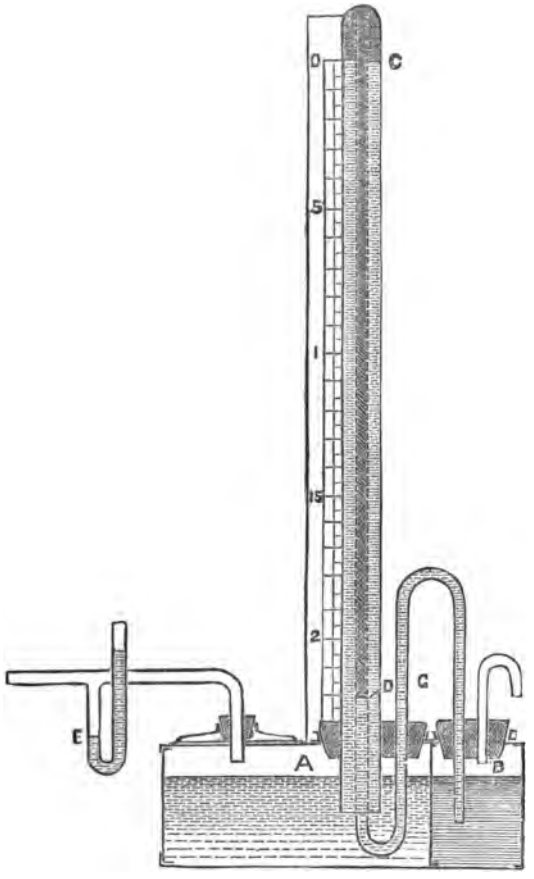
On connecting the compartment on A side of diaphragm with the gas-pipes, while the B compartment is open to the air—a column of red fluid is forced down the inner tube, until the difference of levels of top of water C above bottom of red-fluid D is about 15½ inches—while at the same time the small bent tube E shows a column of water of about 2·2 inches in height balanced by the gas pressure.

A scale affixed to the long vertical tube would thus show a length of column of red-fluid of 7 inches for each

inch of water-pressure in E. Such a length of 7 inches can easily and accurately be sub-divided into 100 parts. Where it may be desirable to have still greater accuracy, a longer range than 7 inches may be obtained by dissolving some paraffin in the benzol, thus approximating its density more to that of water.

Taking the density of water as 1, and supposing the solution of paraffin in benzol to be 0·95, then the range of this fluid would amount to 20 inches for each inch of water-pressure, as given in the equation $\frac{1}{1-0{\cdot}95} = 20$.

In applying this equation a slight correction will be necessary, owing to the raising of level in B compartment and depression in A compartment, equal to the displacement of water in small tube by the tinted fluid.



The apparatus as originally used in 1863 by Mr. T. Ramsbottom, had a glass tube of ∩ form, of equal diameter throughout, giving only a limited range, and some difficulty in reading off the indications.

The modification, as shown in sketch, has a long range while operating with a small amount of fluid; it is easily filled, and easily read off with a sliding scale; the application of a spring clip on the flexible tube at G makes it portable and not liable to get out of order.

Instead of the tin box, as in sketch, a couple of glass bottles may be preferred for permanent use.

Instead of water and benzol different fluids may be substituted, whose relation to one another must, however, be as stated before.

This apparatus commends itself as a portable, cheap, accurate gauge for measuring slight pressure or suction in flues and furnaces, thus ensuring reliable control and accuracy in processes often difficult to estimate correctly on account of inconvenient differences in temperatures.

The Scrutineers then announced the result of the voting, as follows:—

Of 65 votes recorded—

52 were in favour of amalgamation.
3 against amalgamation.
7 in favour of postponing the question.
3 void from non-compliance with conditions of voting.

The proposal to amalgamate with the Society of Chemical Industry was therefore declared to be carried, and the Committee were left to take the necessary steps in arranging matters of detail.

NOTICES OF BOOKS.

A Treatise on the Metallurgy of Iron, containing Outlines of the History of Iron Manufacture, Methods of Assay, and Analyses of Iron Ores, Processes of Manufacture of Iron and Steel, &c. By H. Bauerman, F.G.S. Fifth Edition, revised and enlarged. London: Crosby Lockwood and Co.

This work, having already reached its fifth edition, may be said to have established its claim to the approval of the numerous class interested in the various branches of the iron manufacture. The present edition has been enriched with notices of the hæmatites of Spain and North Africa, and of the oolitic ores of Luxemburg and Lorraine. The modern chemical notation has been adopted, and certain recent improved methods for the determination of manganese have been added, also the modern improvements in the processes of Siemens, Bessemer, Thomas and Gilchrist.

The author, after an introductory sketch, treats successively of the general chemistry of iron, the composition and distribution of its ores geographically and geologically; of the methods preferred for the assay and analysis of the ores, the preparation or dressing prior to smelting; the processes of roasting or calcination, the fluxes employed; the blast-furnace, its accessories and the mode of working; the capacity and production of blast-furnaces and their consumption of fuel and the distribution of the heat. The varieties and composition of pig-iron are next described. The author then passes to the methods of obtaining malleable iron direct from the ore, beginning with the old Catalan process. We have next an account of the refining of grey irons, the production of wrought-iron in open fires, the puddling process, forge and mill machinery, re-heating and welding; the methods of producing steel, including the Bessemer process with its "basic" modification, first made known by Thomas and Gilchrist, and the Siemens process. The author then gives a summary of the methods for the analysis of cast metal, wrought-iron and steel, and of the mechanical properties of and tests of wrought-iron and steel.

Throughout Mr. Bauerman takes a throughly practical view of his subject: his descriptions are full and clear, and the illustrations—49 in number—are carefully drawn.

Practical Chemistry: Analytical Tables and Exercises for Students. By J. Campbell Brown, D.Sc. Second Edition. London J. and A. Churchill. Liverpool: A. Holden.

This work open with a series of exercises on the reactions of the metals. Upon this follows a section on some of the rarer metals, to wit, uranium, cerium, tungsten, molybdenum, vanadium, and titanium. Next come systematic

instructions for the preliminary examination of simple salts and mixtures, rules for effecting the solution of unknown substances and tables for separating the metals into the usual analytical groups, the separate examination of each group, and the examination for mineral acids. There is also a general scheme for the qualitative analysis of organic compounds, whether acids, neutral substances, or bases. Lastly, follow instructions for the detection of gases—a matter which has hitherto been too much overlooked in the more elementary treatises.

The work is well arranged, and contains more valuable matter than might be expected within the compass of 52 pages.

Tables for the Qualitative Analysis of "Simple Salts" and "Easy Mixtures." By Joseph Barnes. Manchester: James Galt and Co. London: Simpkin, Marshall, and Co.

The reader will notice that the words "simple salts" and "easy mixtures" are placed between inverted commas, as if they had in this case some technical meaning. The author avows on the title-page that his tables are intended "for the use of students preparing for the Government Science, Oxford and Cambridge Local, &c., Examinations." We have so often expressed our regret at the circumstances which make such examinational treatises necessary, and our preference for books written for the use of students who wish to acquire a thorough knowledge of the subject, that no more need be said.

Mr. Barnes addresses himself principally to students who are able to devote only an hour or two weekly to laboratory work. We find nothing objectionable in his treatise, but, on the other hand, we scarcely see any marked advantage which it possesses over other manuals, &c., of a similar nature.

Chemical Percentage Tables and Laboratory Calculations. By C. H. Ridsdale, F.C.S. Manchester: Emmott.

One object of the tables before us is to save the time and trouble now often consumed in the laboratory in calculations. By their use the operator can see at a glance, from the weight of the precipitate obtained, the percentage of the substance to be determined in the sample. Not all the bodies commonly requiring to be estimated are included in the author's plan. The tables are applicable either to grain weights or to the metric system.

To many chemists the book will prove a great convenience.

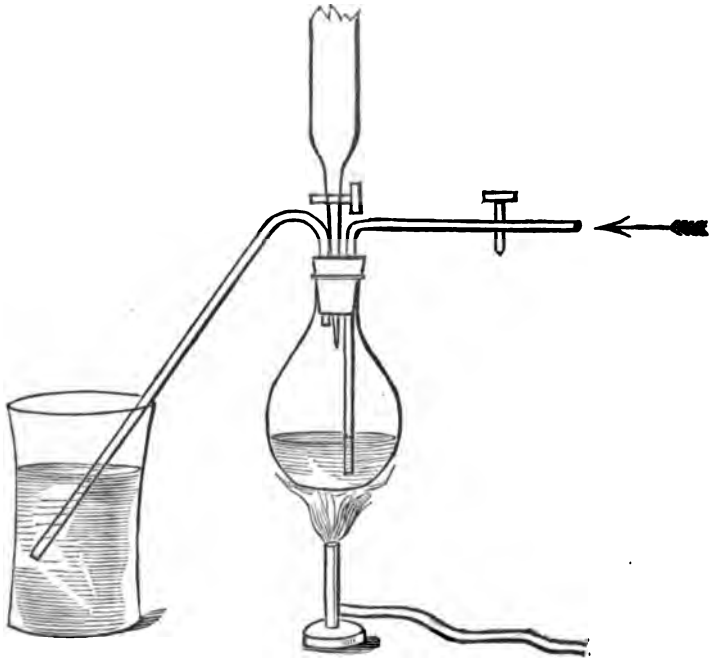
CORRESPONDENCE.

AMMONIO-CUPRIC METHOD FOR THE QUANTITATIVE ESTIMATION OF GRAPE-SUGAR.

To the Editor of the Chemical News.

Sir,—Having had occasion lately to employ Dr. Pavy's ammonio-cupric method for the quantitative estimation of grape-sugar, I have found much advantage to accrue from the following addition to that excellent process:—

After the complete reduction of the cupric solution by boiling with the sugar, *air* is made to bubble through the decolourised liquid in the flask, when the blue colour of



cupric copper at once re-appears, and after passing 1½ litres of air in about *fifteen minutes* through the ammoniacal solution, the copper is found to be completely re-oxidised, and is ready for a second determination with the *same liquid as before.* Care is taken to add a considerable excess of *ammonia solution* in the first instance, to avoid precipitation of Cu_2O by prolonged boiling in the double determination.

The annexed figure exhibits the apparatus employed. The most convenient arrangement for forcing the air through the copper solution I have found to be a "Dancer's Aspirator."—I am, &c.,

G. Stillingfleet Johnson.

Chemical Laboratory,
King's College, W.C.
January 17, 1883.

SCOTCH AMMONIACAL LIQUORS.

To the Editor of the Chemical News.

Sir,—It appears to have escaped the notice of many buyers that since the gas managers have so much added to their washing apparatus the quantity of liquor has greatly increased (in some cases over 50 per cent). The quality, however, has vastly deteriorated, liquor 5 Tw. at 60° now containing only 1·50 to 1·55 per cent of ammonia, or 7 ounces, instead of 2·16 per cent, or 10 ounces, as formerly. The extra washing absorbs H_2S and CO_2, and so the hydrometer is kept up at 5 Tw. as before. The sales are usually made per 100 gallons tar and water *mixed*, and there being no increase, but rather a diminution, in the quantity of the former, the increase in the proportion and quality of the liquor tells very heavily against the buyer. —I am, &c.,

NH_3.

January 25, 1883.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

Sir,—In reply to Prof. Cornwall's complaint in the Chemical News, vol. xlvii., p. 47, of misquotation on my part, I would ask him if, in the case of anyone studying his, or another "Manual," for the purpose of learning a scientific subject, the words "student" and "beginner" are not synonymous, or at all events convertible, terms? When a man has mastered the delicate and difficult operations recommended by Prof. Cornwall in the qualitative analysis of *Smaltite*, he certainly can no longer be called a "beginner;" but then there would be no less impropriety in terming such a master of the art a "student," so that I really fail to see how I have "so completely misquoted this passage." With regard to my further alleged inaccuracy in not completing "the passage"—which is a very long one—in my quotation, the Professor will doubtless by this time see that he has himself committed the same heinous crime in his professedly accurate quotation, which abruptly closes with "if, &c.," the part he has omitted being decidedly favourable to my view, so that after all we are "in the same boat" as to "misquotation."

May I now briefly complain in my turn of the system apparently followed at the John C. Green School of Science, N. J., where Prof. Cornwall admits that, in the preparation of what is intended as (and no doubt otherwise is) an exhaustive work on blowpipe analysis, the author "was until yesterday unaware of the existence" of a work on the same subject, in the same language, which has been in print nearly three years? I presume he has not yet heard of the existence of an English translation of Landauer's excellent little "Manual" published in 1879, nor of the publication in German, at Berlin, in August, 1881, of its second edition? Authors of scientific books in other parts of the world are supposed to collect and digest all the information they possibly can on the subject before publication.

If Prof. Cornwall has never heard of me before, I can only say that I still possess a letter from his publishers, Van Nostrand and Co. (who, by the way, informed my publishers, Trübner and Co., that they would neither keep nor sell my books), warmly thanking me for having written some letters, published in the London *Mining Journal*, in reprobation of a piracy in England of Prof. Cornwall's admirable translation of "Plattner" in 1875: an interference which did me serious injury at the time, and which, being thus thanklessly repaid, I now most heartily regret. —I am, &c.,

W. A. Ross.

Acton, W., January 26, 1883.

Methods and Researches of Physical Chemistry.—O. Pettersson has published two extensive memoirs, in which he treats of the determination of the thermic constants at their melting-points.—*Zeitschr. f. Anal. Chem.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 3, 1882.

Notes on Kissling's Paper on the Determination of Nicotine in Tobacco.—G. Dragendorff.—The writer points out that the method for the determination of nicotine, which Kissling attributes to him, is due to Mayer.

An Apparatus for Furnishing Sulphuretted Hydrogen.—Clemens Winkler.—The apparatus cannot be intelligibly described without the accompanying figure.

Method for the Analysis of Mustard.—A. R. Leeds and Edgar Everhart.—The authors determine moisture and ash as usual. The oil is extracted with ether as follows: A weighed quantity of mustard is dried at 105°, and carefully introduced into a folded filter, which is then placed in a funnel with straight sides. The tube of the funnel is then connected by means of a well-fitting cork with a weighed flask, partly filled with ether. The filter is also connected with an ascending condenser. If the ether is gently warmed this simple extraction-apparatus is brought into action. When all the oil is extracted the apparatus is disconnected, the ether distilled off, the flask and its contents dried at 100°, and weighed. The increase of weight is oil. The residual ether is removed from the mustard by evaporation, and a flask filled with a mixture of equal parts of alcohol and ether is connected to the funnel in place of the one with ether. The extraction-apparatus is again set in action. The dilute alcohol dissolves both the sinapine sulphocyanide and the potassium myronate, but coagulates the myrosine, and leaves it and the cellulose undissolved. After the soluble matter has been extracted the contents of the flask are rinsed into a weighed platinum capsule, evaporated at 105°, and weighed. From the residual potassium sulphate the potassium myronate is calculated, and the sinapine sulphocyanide is found from the difference. The residue in the filter is freed from alcohol by evaporation, and the myrosine and cellulose are treated with a solution of soda at ½ per cent. The solution containing the myrosine is decanted through a weighed filter, and the residue is again treated in the same manner; all the myrosine is thus obtained in solution. The cellulose left on the filter is dried, weighed, ignited, and the ashes weighed and deducted. The solution containing the myrosine is approximately neutralised with hydrochloric acid, about 50 c.c. of Rittshausen's solution of copper sulphate added, then exactly neutralised with dilute soda lye, and the heavy green precipitate containing the copper myrosine compound is allowed to settle. It is collected on a weighed filter, dried at 110°, and weighed. It is then incinerated, and the ash deducted. The total weight of the precipitate, after deducting the ash, gives the myrosine present. In case of mustard adulterated with starch or flour, after extracting the oil with ether and the sinapine sulphocyanide and potassium myronate with alcohol, the residue may be treated with diastase or dilute acid under pressure in order to convert the starch into glucose, which is then determined as usual. Starch is absolutely insoluble in dilute alcohol.

Determination of the Melting-Point of Fats.—Dr. Kretschmer.—Already noticed.

Separation of Barium from Strontium and Calcium by Neutral Potassium Chromate.—J. Meschezerski.—This method, devised by Smith, and since examined by Smith, Fleischer-Kämmerer, and Frerichs, is inconvenient. Strontium chromate is very sparingly soluble in water and acetic acid. One part of the salt requires 840 parts water at 16° for solution. In presence of excess of acetic acid

neutral chromate gives a precipitate even in dilute solutions of strontium salts on standing, which is more abundant at the boiling-heat. One part of barium chromate dissolves in 23,000 parts of boiling water. In acetic acid it is more soluble. Barium chromate has a great tendency to carry down other salts along with it.

Report on General Methods, Analytical Operations, Apparatus, and Reagents.—W. Fresenius.

Self-acting Washing Apparatus.—M. Andreef and L. Cohn.—The former allows the washing water to flow out of a large receiver through a narrow pipe upon the funnel containing the precipitate. When it is full to a certain point the flow of water is interrupted. This is effected in one form of the apparatus by means of an electro-magnet, and in another form on the principle of the balance. The apparatus of Cohn is designed for washing out precipitates on folded filters, and depends on the principle of the extraction-apparatus, as often proposed for determinations of fat.

New Form of Washing-Bottle.—A. E. Johnson.—From the CHEMICAL NEWS.

Asbestos Plugs for Combustion Tubes.—J. Fleming White.—From the *American Chemical Journal*.

Capsules and Funnels of Papier-Maché—These vessels bear heating on the water-bath, and are little affected by fatty and mineral oils, dilute acids, solutions of sodium carbonate, and other salts. Ether and alcohol at 96° soften the varnish in course of time. Caustic alkalies, even if very dilute, have an energetic action.

Spirit Lamp.—G. Munder.—The author recommends the common petroleum lamps as well adapted for burning spirit. He recommends the insertion of a piece of brass wire gauze in the inner channel to prevent the flame from striking down.

Universal Gas-burner.—P. Gebhardt.—This arrangement is said to be equally well adapted for a common Bunsen burner and for a blast.

Blowpipe with Constant Blast.—A. Koppe.—Differs little from the forms proposed by Dupré and J. Rabs. J. J. Hesz proposes a blowpipe, the point of which is surrounded by a double jacket. A side tube leads into the outer space, from which air is carried along.

Occurrence of Arsenic and Vanadium in Commercial Soda.—E. Donath.—The presence of arsenic in soda made with acid from pyrites is well known. The proportion of vanadic acid in some sodas is said to be 0·014 per cent. This impurity may give rise to errors in analyses.

Contamination of Litharge and Lead Acetate with Calcium Sulphate.—M. Schlagdenhauffen.—Three samples of litharge contained 0·35, 0·80, and 1·15 per cent of calcium sulphate, and in different samples of lead acetate the impurity ranged up to 4·44 per cent.

Chemical Analysis of Inorganic Bodies.—E. Hintz.

Spectrum of Oxygen.—A. Paalzow and H. W. Vogel.—The details are not given.

Determination of Potassium.—F. Mohr.—The process is based on the volumetric determination of chlorine in the precipitate of platinum potassium chloride. He fuses the double chloride with double its weight of sodium oxalate, extracts the melt with water, and determines the chlorine volumetrically in the solution. M. L. L. de Koninck proposes a modification of this process, which has been noticed in the CHEMICAL NEWS.

Separation and Determination of Potassium as Potassium Platinum Chloride.—David Lindo.—From the CHEMICAL NEWS.

Method for Determining Potassa and Soda in Potash.—H. Hager.—The process assumes that no other substance but the alkaline carbonates is present. The author mixes the carbonates with 4 parts of picric acid, moistens with water, heats, and evaporates on the water-bath. The dry mass is ground to powder, repeatedly extracted with absolute alcohol, and washed with alcohol of the same strength till no residue appears on evaporating the washings upon a slip of glass. The potassium picrate thus obtained is dried at 100°, and weighed. Its weight divided by 3·8 gives the corresponding quantity of anhydrous potassium carbonate. To determine the soda in the alcoholic filtrate the alcohol is distilled off, the residue is taken up in a little water, and evaporated to dryness. The sodium picrate may be freed from excess of picric acid by extraction with benzol. The weight of the sodium picrate dried at 100° and divided by 4·736 gives the corresponding anhydrous sodium carbonate.

Separation of Zinc from Cadmium and Determination of the Latter.—M. Kupfferschläger.—From the *Bulletin de la Soc. Chimique*.

Method of Determining Precipitated Copper Sulphide.—From the *Journal für Prakt. Chemie*.

Chemical Analysis of Organic Bodies (1. Qualitative Detection of Organic Bodies).

Recognition of Primary, Secondary, and Tertiary Alcohols and Alcohol Radicals.—Meyer and Locher have previously given very characteristic colour reactions (*Zeit. Anal. Chemie*, xiv., p. 371). H. Gutknecht has made experiments to ascertain to what members of the alcohol series these reactions may be observed. He finds that the reaction for secondary alcohols occur only in propylic, butylic, and amylic alcohol; among the primary alcohols it appears in octylic alcohols, and probably even in higher members of the series.

Attropine, Daturine, Duboisine, Hyoscyamine, and Hyoscine.—A. Ladenburg.—From the *Berichte der Deutsch. Chem. Gesellschaft*.

Quantitative Determination of Organic Bodies (*a*. Elementary).

A Modification of Varrentrapp and Will's Method of Determining Nitrogen.—J. Ruffle.—From the *Journal of the Chemical Society*.

Determination of Tannin.—A. Lehmann.—A quantity of the sample, supposed to contain 0·2 to 0·6 grm., is repeatedly extracted with fresh quantities of hot water; when cold the mixed extracts are made up to a fixed volume (100 or 200 c.c.), and filtered through a dry filter. To 10 or 20 c.c. of this solution, mixed with an equal volume of a cold saturated solution of sal-ammoniac, solution of gelatin is run in from a burette divided into tenths of a c.c. as long as a precipitate is formed. The solution is prepared by dissolving 1 grm. gelatin in 100 c.c. of a cold saturated solution of sal-ammoniac. If this precaution is observed the precipitate always clots together and settles well. To detect the end of the reaction a few drops of the supernatant fluid is drawn through a small filter into a glass tube. If the end is reached the liquid is rendered turbid neither by a drop of tannin solution nor by a drop of gelatin solution.

Picrates of the Alkaloids.—H. Hager.—The author recommends this form as convenient for weighing, especially for the Cinchona alkaloids.

Special Analytical Methods.—F. Hofmeister and W. Lenz.

Sanitary Examination of the Air in Closed Spaces.—To determine the dryness of the air Niedner makes use of a sensitive balance beam to one of whose arms is fixed a frame of 1000 square centimetres surface covered with the finest linen. It is moistened with water, weighed, and the author observes how much water evaporates in a given time. Or the seconds are counted which are required for the evaporation of a given quantity of water.

Determination of Carbonic Acid in Expired Air.—W. Marcet.—From the *Journal of the Chemical Society*.

The Areometric Method for Determining the Fat in Milk.—M. Soxhlet.—Soxhlet's method is applicable only to milks of 2·07 to 5·12 per cent fat. For skim-

milks it is often inapplicable. If skim-milk is to be examined, in this method 200 c.c. of the sample are mixed with 0·4 to 0·5 c.c. soap-lye.

Water Analysis: Detection of Lead and Nitric Acid.—From the *Analyst* and the CHEMICAL NEWS.

Analysis of Wine.—J. Piccard.—The author finds that the method of Berthelot and Fleurien for determining tartar and free tartaric acid is not always satisfactory. It is preferable to mix 10 c.c. of wine with some crystals of potassium acetate, 2 or 3 drops of acetic acid, 25 c.c. alcohol, the same volume of ether, and a pinch of sand. The whole is placed for seventy-two hours in an ice-closet, and is shaken from time to time, filtered, and the deposit of tartar is determined by known methods.

Determination of Succinic Acid.—R. Kayser.—The author evaporates 200 c.c. down to one-half, adds lime-water until the reaction is alkaline, and filters, which removes the tartaric acid, and especially the phosphoric acid. Excess of lime is removed by a current of carbonic acid, the liquid is boiled, and in the neutral filtrate the succinic acid is thrown down by ferric chloride as basic ferric succinate, washed with alcohol at 70 per cent, dried, ignited, and the residue (iron oxide) weighed.

Determination of Malic Acid.—R. Kayser.—The author modifies Nessler's process as follows: 100 c.c. of wine are evaporated down to one-half, supersaturated with sodium carbonate, mixed with 10 c.c. of concentrated solution of barium chloride in a graduated agitation cylinder holding 100 c.c., filled up with water to 100 c.c., well shaken, and let stand for twelve to twenty-four hours. Only the malic and acetic acids of the wine remain in solution. The latter is filtered, an aliquot portion of the filtrate is mixed with hydrochloric acid in excess, and evaporated to dryness in the water-bath. Free hydrochloric acid and acetic acid are volatilised, and only neutral chlorides and free malic acid remain, the quantity of which is determined acidimetrically. If the wine is strongly coloured it is first decolourised with animal charcoal.

Acetic Acid.—R. Kayser.—The author's method cannot be described without the accompanying figure.

Potassa in Wines.—R. Kayser.—The author dissolves 0·7 grm. soda crystals and 2·0 grms. tartaric acid in about 100 c.c. wine, adds 150 c.c. alcohol of 92 to 94 per cent, and lets it stand twenty-four hours. The separated tartar is collected on a small filter, washed with so much alcohol at 50 per cent that the filtrate makes up 260 c.c.; the tartar together with the filter is returned to the beaker in which the precipitation takes place, dissolves it in hot water, the solution is made up to 200 c.c., and 50 c.c. are titrated with decinormal soda. According to the author's experiments on the precipitation of the tartar, about 0·004 potassa remains in solution.

Sulphuric Acid in Pure Wines.—E. List.—Pure German white wines may contain as much as 0·08986 grm. per litre sulphuric acid (SO_3). In Madeira there may be 0·11920 sulphuric acid, though the ash retains its strong alkaline reaction,—a characteristic of genuine wines. According to B. Haas, V. Wartha's method for detecting and determining sulphurous acid in wines is deceptive, since wines of undoubted purity may yield a distillate having the reactions which Wartha pronounces characteristic of sulphurous acid, especially the turbidity with silver nitrate, disappearing on the addition of nitric acid. According to L. Liebermann the substance concerned is identical with formic acid. Even acetic acid precipitates silver nitrate in a strongly alcoholic liquid. Haas determines sulphurous acid in wine by putting 100 c.c. of the sample in a flask holding 400 c.c., and distilling in a current of carbonic acid down to one-half. As a receiver he uses a Péligot's tube (the bulbs of which hold about 100 c.c.) containing 30 to 50 c.c. solution of iodine. Before beginning the operation the apparatus is filled with carbonic acid. The Péligot tube is kept immersed in cold water and the escape tube for steam may also be refrigerated. When the distillation is at an end the solution of iodine is rinsed into a beaker, heated with a little hydrochloric acid, and the sulphuric acid formed is determined in the usual manner.

Colouring-Matter of Wine.—A. Dupré contests the alleged identity of the colouring-matters of the grape and of the bilberry (*Vaccinium myrtillus*), since the latter dialyses easily, but the former with difficulty. For the detection of logwood colour in wine, A. Pizzi shakes up 20 c.c. wine with 2 grms. manganese peroxide, and filters. The filtrate is reduced with zinc and hydrochloric acid, thus forming hæmatoxyline, which is detected by the usual tests. If the liquid, on treatment with a neutral solution of ferrous sulphate, turns deep violet, hæmatoxyline is present. A reddish brown colour indicates brasiline

Detection of Various Colours in Wine.—H. Macagno.—From the CHEMICAL NEWS.

Examination of Flour.—G. Steenbuch.—In order to isolate the fragments of tissue which are more characteristic than the starch granules, the author stirs up 10 grms. of the flour with 30 to 40 grms. distilled water to a uniform paste, and then adds 150 grms. boiling distilled water. The whole is let cool down to 50° to 60°, and 30 c.c. of a filtered extract of malt are added, made by macerating for an hour 20 grms. ground malt with 200 grms. cold water. The mixture is heated for ten minutes to 55° to 60° in the water-bath, then poured into a larger quantity of water, repeatedly decanted, pouring off the liquid as far as possible from the sediment, and digesting the latter at 40° to 50° with soda-lye at 1 per cent., thus dissolving the amorphous albumenoid matters. The liquid is again poured into a larger quantity of water, and deposits the elements of the tissues in a form well suited for microscopic examination. This process is well suited for other powders containing starch, such as cinnamon, and cocoa, which must be previously freed from fat.

Specific Gravity of Butter.—A. W. Blyth.—From the *Analyst*.

Execution of Berthier's Method of Determining the Heating Power of Fuel.—C. L. Munroe, instead of a crucible uses a non-galvanised iron-tube, 1 inch in diameter and a foot long. One end is closed with a well-fitting screw-stopper, and to the other end is screwed a ½-inch tube 3 feet long. 1 grm. of the coal in question is mixed with 40 grms. of litharge, put in the tube, and covered with a stratum of unmixed litharge. It is then placed in the furnace of a steam-boiler, so that the open end projects out about 6 inches, and is heated till no more pressure is felt on closing the open end with the finger. The whole process lasts about ten minutes. The tube is taken out, and set with its closed end downwards so that the melted lead may sink to the bottom. The screw is then opened, the lead is run out, and its weight gives a measurement for the reducing power of the coal.

Analysis of Iron Ores containing Phosphoric and Titanic Acids.—T. M. Drown and P. W. Shimer.—This process is not described.

Determination of Basic Slags and Oxides in Wrought-iron.—W. Bettel.—From the CHEMICAL NEWS.

Volumetric Determination of Sodium Sulphate in Salt-cake.—A. Bertrand.—From the *Monitcur Scientifique*.

Determination of Sulphur in Sulphides, Coal, and Coke.—T. M. Drown.—From the CHEMICAL NEWS.

Table of the Specific Gravities of the Solutions of Sulphur in Carbon Disulphide.—H. Macagno.—From the CHEMICAL NEWS.

Analysis of Sulphuric Anhydride and Fuming Sulphuric Acid.—O. Clar and J. Gaier.—The authors weigh the fuming acid in thin glass bulbs of 20 m.m. in diameter, provided with two long capillary points opposite to each other. The bulbs are half-filled with the acid by suction, and are then sealed up at both ends. After

weighing, a point is broken off under water. The anhydride is weighed in small glass bottles 58 m.m. high, 17 m.m. wide, with high ground stoppers, enlarged conically above, and with a small aperture in its summit closed with a minute glass plug. The interior of the stopper is filled with glass wool, slightly moistened. The bottle when charged and weighed is allowed to glide in an inverted position into a 2-litre flask held in a sloping position, and containing about 500 c.c. water at 50° to 60°. After mixture has taken place through the small aperture in the stopper, the liquid is made up to 1 litre, and a portion of 100 c.c. is titrated with 5-normal soda.

Examination of Chamber and Tower Gases.—G. A. Davis.—From the CHEMICAL NEWS.

MISCELLANEOUS.

Popular Science.—The following is from a recent number of the *Ashton Reporter*:—

"WATER CARRIED AS GAS.—M. Pasteur, a nephew of the celebrated chemist of that name, has recently adapted an old discovery to great practical use. It is a well-known fact that the crossing of the great African Desert is accomplished by means of caravans composed of camels, horses, &c., the water for which has to be transported on the back of the consumer. This lessens to a great degree their freighting capacity. M. Pasteur has established suitable works at the numerous termini of the routes for separating the water into oxygen and hydrogen. As the latter is sixteen times lighter than the former, and is the gas used in balloons, it carries the oxygen and a considerable part of the camel, besides furnishing light on dark nights. He unites the gases by the simple means of explosion when desired for use. The French Government has created M. Pasteur a commander of the Legion of Honour for his great adaptation."

Society of Arts.—The following are the premiums offered by the Society of Arts for the 129th Session of the Society (1882-3):—John Stock Prize.—A Society's Gold Metal, or £20, for the best design, from a poem, or from history, or from the Scriptures, prepared with a view to Mural Decoration. Benjamin Shaw Prize.—1. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the operations of coal-mining." 2. A Society's Gold Medal, or £20, for the best plan for "obviating or diminishing risk to life in the manufacture, storage, and transport of explosives." The Council of the Society leave it to the competitors to bring the plans under their notice in any way they may think proper, whether by model, written description, or otherwise. Howard Prize.—A prize of £100, for the best Essay on the Utilisation of Electricity for Motive Power. Preference is to be given to that Essay which, besides setting forth the theory of the subject, contains records with detailed results of actual working of experiment. The Society reserves the right of publishing the prize essay. Fothergill Prize.—A Society's Gold Medal, or £20, for the best Invention having for its object the Prevention or Extinction of Fires in Theatres, or other Places of Public Amusement. Mulready Prize.—A Society's Gold Medal "To that Student in a School of Art in the United Kingdom who exhibits the best Drawing from the nude figure, executed in black and red chalk, in the manner so successfully practised by Mulready." Designs, plans, models, essays, descriptions, inventions, &c., intended to compete for any of the above Prizes, must be sent in on or before the 31st October, 1883, to the Secretary of the Society of Arts, John Street, Adelphi, London. The Council of the Society reserve the right of withholding any or all of the above Prizes, or of awarding others of lesser value in their stead, in any case in which there is nothing in their opinion deserving the award, or sufficiently complying with the conditions, sent in for competition.

NOTES AND QUERIES.

**** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Spanish White.—What is the chemical name for a substance known as "Spanish white," and where can it be obtained?—G. P.

MEETINGS FOR THE WEEK.

MONDAY, Feb. 5.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field, F.C.S.
— Society of Chemical Industry, 8. "On the Chemistry and Methods of Examining Fixed Oils," by A. H. Allen, F.C.S. "On Chamber Exit Gas Testing," by Mr. W. Pringle.
— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 6th.—Royal Institution, 3. "Primæval Ancestors of Existing Vegetation," by Professor W. C. Williamson.
— Institution of Civil Engineers, 8.
— Pathological, 8.30.
— Society of Arts, 8. "Social Conditions and Prospects in Madagascar," by the Rev. J. Peill.
WEDNESDAY, 7th.—Society of Arts, 8. "The Modern Lathe," by Mr. J. H. Evans.
— Geological, 8.
— Pharmaceutical, 8.
THURSDAY, 8th.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
— London Institution, 7.
— Royal, 4.30.
— Royal Society Club, 6.30.
FRIDAY, 9th.—Royal Institution, 8. "Emerson and His Views of Nature," by Mr. M. D. Conway, at 9.
— Astronomical, 3. Anniversary.
— Quekett Club, 8.
SATURDAY, 10th.—Royal Institution, 3. "The Siege and Capture of Delhi," by Mr. R. Bosworth Smith.
— Physical, 3. Annual General Meeting. "On the Graphic Representation of the Duty and Efficiency of Electric Motors," by Prof. Silvanus P. Thompson.

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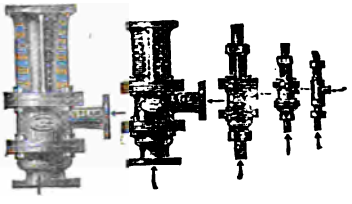

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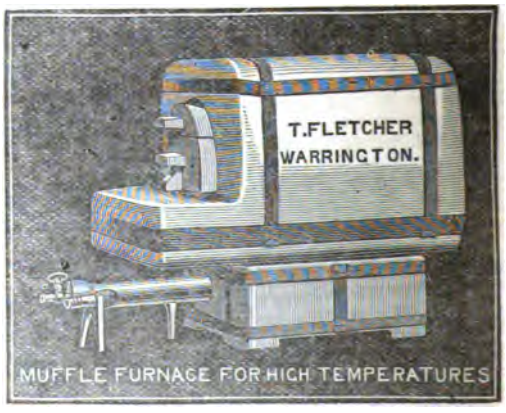

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1211.

NOTE ON THE ABSORPTION SPECTRUM OF IODINE IN SOLUTION IN CARBON DISULPHIDE.*

By Captain ABNEY, R.E., F.R.S., and Lieut.-Colonel FESTING, R.E.

In 1876, Sir John Conroy (*Proc. Roy. Soc.*, vol. xxv., p. 46), described the absorption spectrum of a solution of iodine in carbon disulphide. He, however, solely regarded the visible spectrum from near B to above G, about wave-length 4000.

Our attention was recently directed to the absorption of this substance, and we have determined photographically the spectra for different thicknesses and strengths of the solution.

Our inquiries into the behaviour of carbon disulphide had shown us that it, as well as iodine, was transparent for rays of very low refrangibility, as was first shown by Prof. Tyndall. We are not aware, however, that any investigations into the absorption at the more refrangible end of the spectrum have been published. An idea seems to be prevalent that the absorption commences in the green, and gradually extends, as the thickness or density of the solution is increased, in both directions until finally all the visible rays are extinguished, leaving the invisible rays at both ends unabsorbed.

Though one of us employed the solution before to cut off the visible portion of the spectrum (*Phil. Trans.*, part ii., 1880, p. 664) in diffraction photography of the lower part of the spectrum, the use of it was abandoned owing to the opinion that was expressed that instead of the infra-red being photographed, the ultra-violet and violet of the spectrum of the next order might be that which was really impressed. Our recent experiments, however, show that no fear need have been entertained on this account, as the annexed diagram will show.†

The following thicknesses and strengths of solution were employed, being placed before the slit of the photographic spectroscope :—

	Iodine in CS_2.		Thickness.	
No. I....	4 per cent	equivalent to	2	millims.
„ II....	8	„	2	„
„ III....	12	„	2	„
„ IV....	16	„	2	„
„ V....	32	„	2	„

The source of light was usually the crater of the positive pole of the electric lamp, though in two instances we were favoured with a glimpse of sunshine, which enabled us to confirm what we had before obtained with the less brilliant source of light. For Nos. I., II., and III., photographs were taken, which gave the red and infra-red spectrum, as well as the more refrangible end. With every number ordinary gelatin plates of great sensitiveness were employed as a check on the collodion plates. To the eye the red, in each case, extends a trifle more towards D than in the photograph.

An attempt was made to produce the same range of photographic action in the spectrum of the thicker solutions as in the less dense, by increasing the time of exposure. The result, however, was abortive, and hence we may conclude that when any visible ray is quenched to sight by a solution of particular density, it also ceases to be photographically active.

The last ray to disappear in the blue lies somewhere close to *h*, and it will be seen that the ultra-violet rays are absorbed before the absorption touches the violet. By using a still denser solution than No. V., we are able to entirely quench the blue, both visually and photographically, while the extreme red was still visible, and the photograph taken showed no signs of absorption of the infra-red rays.

In conclusion we would remark, that by the use of this solution in a rock-salt cell and a grating, the infra-red spectrum from λ·7600 to λ·15,200 may be photographed without the instrumental separation of the different orders of spectra; and the conditions of our climate are such that the atmospheric absorption usually, if not always, prevents a study of the solar spectrum below the greater wave-length above-named.

* A Paper read before the Royal Society, Jan. 25, 1883.

† This diagram represents the absorption of the continuous spectrum. The bright bands in the electric light above K had power to penetrate the solutions II. and III.

PRELIMINARY NOTE ON A THEORY OF MAGNETISM BASED UPON NEW EXPERIMENTAL RESEARCHES.*

By Prof. D. E. HUGHES, F.R.S.

In the year 1879† I communicated to the Royal Society a paper "On an Induction Currents Balance and Experimental Researches made therewith." I continued my researches into the molecular construction of metallic bodies, and communicated the results then obtained in three separate papers‡ bearing upon molecular magnetism.

To investigate the molecular construction of magnets required again special forms of apparatus, and I have since been engaged upon these, and the researches which they have enabled me to follow.

From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—

1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in this direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but

* A Paper read before the Royal Society, Feb. 1, 1883.

† *Proc. Roy. Soc.*, vol. xxix., p. 56, 1879.

‡ *Proc. Roy. Soc.*, vol. xxxi., p. 525; vol. xxxii., pp. 25, 213, 1881.

one whose circles of attraction are not completed except through an external armature joining both poles.

The experimental evidences of the above theory are extremely numerous, and appear so conclusive, that I have ventured upon formulating the results in the above theory.

I hope in a few weeks to bring before the Royal Society the experimental evidence which has led me to the conclusions I have named; conclusions which have not been arrived at hastily, but from a long series of research upon the molecular construction of magnetism now extending over several years.

ON THE EVAPORATION OF LIQUIDS, AND IN PARTICULAR OF MERCURY, IN A SPACE FREE FROM AIR.

By H. HERTZ.

If a liquid evaporates in a gas the pressure of which is greater than the pressure of the saturated vapour of the liquid, the vapour in the neighbourhood of the surface is always very close upon the state of saturation, and the speed at which evaporation takes place is primarily dependent upon the speed with which the arising vapour is removed. The removal of the vapour, at least in the strata near the surface, takes place in the way of diffusion. Proceeding from this view, the evaporation of a liquid in a gas has often been taken into consideration. But hitherto it appears no attention has been given to the conditions which regulate the speed of evaporation in a space which, in addition to the liquid, contains merely its own vapour. In the first place, evaporation in a space free from air is conditioned by the speed with which the vapour formed can escape, in as far as such escape, under certain circumstances, is much delayed by internal friction; this condition is evidently very unessential. For if we conceive the evaporation as taking place between the plane and parallel liquid surfaces, it might proceed with an infinite speed. The rate at which heat is conveyed to the surface of the liquid may be given as a condition of the evaporation. In the stationary condition exactly such a quantity of liquid will evaporate that its latent heat is equal to the heat conveyed to it; but this explanation is imperfect, since with an equal right the supply of heat might be conversely regarded as determined by the evaporation. Both depend on the temperature of the external surface, and this again depends on the proportion between the heat possibly supplied by conduction and the heat possibly lost by evaporation. The case may be twofold:—Either, *a*, the evaporation has no other limit than that fixed by the supply of heat and from a given surface; an unlimited quantity of liquid may evaporate in a unit of time, if the supply of heat is sufficient without the temperature, the density and the pressure of the escaping vapour being notably different from those of saturated vapour. All liquid surfaces in the same space must assume an equal temperature, and this temperature, as well as the quantities of liquid evaporating, are conditioned by the relation of the possible supply of heat to the different surfaces. Or, *b*, from a liquid surface at a given temperature only a limited quantity of liquid can evaporate. Then, in the same space there can exist surfaces of different temperatures, and the pressure and density of the vapour passing off must be different from the pressure and density ot the saturated vapour of at least one of these surfaces of a finite quantity. The rate of evaporation depends, beside a series of secondary conditions, also, in the first place, on the nature of the liquid, a specific power of evaporation existing for every liquid.

It will be seen that the alternative *a* can be regarded as an extreme case of *b*, and that without hypothesis or decisive experiment only the latter, more general, view can be accepted as correct. It will appear below that the former alternative may be regarded as extremely improbable.

In order to obtain an experimental decision between the two above-mentioned alternatives, if possible by the exact measurement of the evaporative power of any liquid under different circumstances, the author has instituted a series of experiments on evaporation in space free from air, which, however, have only partially effected their object. They are nevertheless described, as they are calculated to show more clearly the problem in question, and perhaps to point a way to better methods. To the description is appended a series of considerations which are to justify the fundamental conceptions, and to fix limits at least for the values to be dealt with.

In his experiments the author proceeded from the assumption that the rate of evaporation from a surface must be determined by the temperature of the surface, and the pressure exerted upon it by the escaping vapour. In the course of the investigation doubts occurred, not whether these two magnitudes were essential, but whether they were sufficient conditions for the quantity of the liquid evaporated. This doubt was found to be baseless. The immediate problem was therefore to find for any liquid the values of the temperature (t) of a surface, of the pressure (P) upon it, and the depth (h) of a stratum of liquid evaporating in a unit of time. The difficulty of this apparently simple problem lies in the determination of t and P. If the evaporation is even, but moderate, very considerable quantities of heat are needed to keep it up. Hence the temperature increases rapidly from the surface downwards, and if a thermometer is plunged but a little way into the liquid it no longer indicates the true temperature of the surface. The experiments show, further, in case of a moderate evaporation, the deviation of the pressure from that of saturated vapour, and, as this deviation is the essential point, it follows that both pressures must be measured very accurately. Lastly, it must be considered that in these experiments the liquids must be in their interior in a superheated state: as a "bumping" ebullition would render the experiments impossible, we are restricted to a very narrow margin both in temperature and pressure.

(The description of the author's experiments cannot be reproduced without the aid of the three accompanying figures.)

The total result of the experiments is but limited; they show that the pressure of the escaping vapour upon the liquid may be considered equal to the pressure of the saturated vapour corresponding to the surface temperature, and that therefore the first alternative, as mentioned above, may be adopted as correct. They do not show with certainty the small deviation from this rule, which probably takes place, and which is the point of theoretical interest.

We consider the stationary process of evaporation which occurs between two infinite, plane, parallel liquid surfaces, when they are kept at constant temperatures differing for both surfaces, and when a way is afforded by any passages soever for the evaporated liquid to return to its point of departure. All particles of vapour will pass from the one to the other surface in the direction of their common normals, and we may assume with sufficient approximation that during this transit they will neither take up nor give off heat, if we disregard the effects of radiation. On this supposition the hydrodynamic equations of movement show that the pressure, the temperature, the density, and the speed of the vapour must be constant during the entire transit from one surface to the other, whatever may be the distance. Hence follows that we know completely the occurrence in question if we can give the following magnitudes:—

1. The temperatures T_1 and T_2 of the two surfaces.
2. The temperature T, the pressure p, and the density d of the steam passing over. The temperature must be

conceived as measured by means of a thermometer moving on with the vapour with equal speed; the pressure p is also measured by a manometer moving along with the vapour, or as determined from the equation of condition of the vapour. For the latter we may approximately assume the equation of the perfect gaseous state, and therefore put $RI = p/d$.

3. The speed u, and the weight m, which passes over from a unit of the one surface to the other in a unit of time; evidently $m = u\,d$.

4. The pressure (P) which the vapour exerts upon the liquid surfaces. It is necessarily equal for both surfaces, and different in itself from the pressure p. We can calculate P if the other magnitudes mentioned are given. If we conceive the quantity m extended upon the unity of the surface, the pressure P resting upon the one side and the pressure p upon the other, and the temperature kept constant at T_1, it will evaporate exactly as before, and after the unit of time it will be completely converted into vapour, will take up the space u (?), and have attained the speed u. The *vis viva* of its visible motion is therefore $\frac{1}{2} m u^2/g$, and this is obtained by the centre of gravity under influence of the power $P-p$ traversing the distance $\frac{1}{2} u$, external powers therefore performing the work $\frac{1}{2}(P-p)u$. Hence follows the equation $P-p = mu/g$, or, in conjunction with the equation under 3, $m^2 = g\,d\,(P-p)$.

The problem presented by evaporation is then to find the relation between these magnitudes for all their admissible values. Of the eight magnitudes, T_1, T_2, T, p, d, u, m, P, evidently two, T_1 and T_2, and then any two others, are independent variables; the other six are connected with these by six equations: three of these equations have been given above. For a complete solution three further equations are required, either according to theory or experiment. If we select in the experiments T_1 and P as independent variables, and confine our attention to evaporation in the strictest sense, T_2 does not concern us, and the problem remains of presenting two of the magnitudes, T, p, d, u, m, as functions of T_1 and P. These functions to be determined refer not merely to the case of evaporation taking place between two parallel surfaces, but they stand good for every vapour which rises from a plane liquid surface of the temperature T_1, and exerts upon it the pressure P. For we can conceive this evaporation taking place in such a manner that upon a surface of the temperature T_1 we allow a piston to rest, and then withdraw it from the surface at a given moment with the speed u; the result of this experiment must be determined by T_1 and u, but a possible result is afforded us by the two functions just mentioned, and this therefore is the only one possible.

Hence the magnitudes relating to an evaporating surface are determined by two of them, and the supposition upon which the experiments were based is justified. On the other hand, our considerations show that these experiments, even if successful, would not exhaust the problem.

For the magnitudes concerned we may obtain limits if we make use of two propositions the correctness of which is rendered highly probable by general experience. They are the following:—

1. If we lower the temperature of one liquid surface among several existing in the same space whilst the temperature of the rest remains at its original point, the mean pressure upon these surfaces will thereby decrease, not increase.

2. The vapour arising from an evaporating surface is saturated or unsaturated, not supersaturated. For it appears always perfectly transparent, which would not be the case if it carried with it drops of liquid. According to the first proposition $P < p_{-1}$; according to the second $d < d_p$, if we understand by p_1 the pressure of the saturated vapour at the temperature T_1, and by d_p the density of the saturated vapour at the pressure p. But—

$$m = \sqrt{g\,d\,(P-p)},$$

and consequently—

$$m < \sqrt{g\,d_p\,(p_1-p)}.$$

The right member of this un-equation becomes null for $p=0$ and for $p=p_1$, and reaches a greater value between these two pressures, which m for the surface temperature (T_1) never exceeds. But if, in spite of a sufficient supply of heat, the evaporation cannot exceed a finite limit, the hindrance lies in the nature of the liquid, and every liquid must have a specific evaporative power. The existence of such a one has therefore the same degree of probability as the two assumptions upon which our conclusion is based. The author has calculated from the above equation the following limit for m, assuming the law of Gay-Lussac and Mariotte to hold good as vapours, and adopting the following expression for the relation between the pressure and the temperature of saturated vapour:—

$$\text{Log. } p = 10{\cdot}59271 - 0{\cdot}847 \text{ log. } T - 3342/T.$$

Dividing the magnitudes (m) obtained by the specific gravity of mercury, he obtained values for the utmost depth of the liquid stratum which in a unit of time can evaporate from a surface at a given temperature. These values, calculated in m.m./minutes, are—$T = 100$, $h < 0{\cdot}70$, $u < 2110$, $P > 0{\cdot}046$, $d/d_1 > 0{\cdot}0034$. These values are about ten times higher than the highest values which have been observed at corresponding temperatures. The latter the author gives as the minimum limits, not for evaporation in general, which may be null, but they are minimum limits for the greatest possible rate of evaporation. The figures show that we are unable to effect by any means the evaporation at 100° of more than 0·7 m.m. per minute from a surface of mercury; that the vapour from the surface exhales at a greater speed than 2110/m. sec. from the surface; that the pressure upon the surface is smaller than 4 to 5 hundredths of a millimetre; or that the density of the exhaled vapour is less than 1-300th of the density of saturated vapour. On the other hand, we may effect an evaporation of more than 0·08 m.m./minute, that the speed of the vapour is greater 7·3 m./sec., and that the pressure of the exhaling vapour differs from that of saturated vapour by more than 1-300th of the value of the latter.

In conclusion, the author remarks that the existence of a definite rate of evaporation peculiar to every liquid corresponds to the views of the kinetic theory of gases, and that a tolerably certain maximum limit for the speed in question can be founded upon this conception. Let T, p, and d be now respectively the temperature, the pressure, and the density of saturated vapour, then—

$$m = \sqrt{p\,d\,g/2\pi}$$

is that weight which in a unit of time impinges upon a solid surface forming the boundary of the vapour. Almost the same quantity must in a very rare vapour impinge upon the liquid boundary surface, as the molecules at their mean distance from the surface will be withdrawn from the influence of the latter. But as the quantity of saturated vapour neither increases nor decreases, we may conclude that an equal quantity of the liquid is thrown off as vapour. This quantity proceeding from the liquid will be almost independent of that taken up. Hence occurs decrease of the liquid, because the vapour from whatever grounds brings back to the liquid a smaller weight than that just named; and in the extreme case, that no molecules return to the liquid, the latter, in a unit of time, will lose the above quantity from a unit of its surface. This quantity is therefore the maximum limit of the speed of evaporation, and is somewhat lower than that formerly ascertained. For mercury calculation shows this limit at 100° to be 0·54 m.m. per minute, whilst from our former suppositions we could merely infer that the rate of evaporation must fall short of 0·70 m.m. per minute. Similar conclusions may be applied to the energy which can at most proceed from an evaporating surface. It appears that the speed of the exhaling vapour can never be greater than

he mean molecular speed of the saturated vapour corresponding to the surface temperature; *e.g.*, for mercury, at the temperature of mercury, it never can be greater than 215 m./sec. As the pressure of a saturated vapour upon its liquid proceeds to the extent of one-half from the shock of the molecules entering the liquid, the other half being due to the reaction of the molecules leaving the surface, and as the number and the mean speed of the latter remain approximately at their original value, it may be inferred that the pressure upon an evaporating surface is not essentially less than the half of the saturation pressure.

These considerations can merely be used for establishing limit-values, unless we are prepared to call in the aid of very questionable hypotheses.—*Wiedemann's Annalen* (1882, p. 177.)

DETERMINATION OF PHOSPHORIC ACID BY THE MOLYBDIC METHOD.

By Dr. C. STUNKEL, Dr. T. WETZKE, and Prof. PAUL WAGNER.

According to the authors' experience the subjoined is the best method of carrying out this process:—

From 20 to 25 c.c. of a solution of phosphate free from silica and containing 0·1 to 0·2 grm. of phosphoric acid, are placed in a beaker, and mixed with so much solution of ammonium nitrate (see below), and so much molybdic solution, that the total liquid may contain 15 per cent ammonium nitrate, and not less than 50 c.c. of molybdic solution per 0·1 grm. phosphoric acid. The contents of the beaker are heated to 80° to 90° in the water-bath, set aside for an hour, filtered, and the precipitate washed with dilute solution ammonium nitrate. The beaker is now set under the funnel, the filter pierced with a platinum wire, the precipitate rinsed into the beaker with ammonia at 2½ per cent, washing the filter-paper well, dissolved, stirring with a glass rod, and ultimately so much of the weak ammonia added as to make up the volume of the liquid to about 75 c.c. To 0·1 grm. phosphoric acid 10 c.c. magnesia mixture are dropped in, stirring continually; the beaker is covered with a glass plate, and set aside for two hours. The precipitate is then filtered off, washed with ammonia at 2 per cent, and dried. The precipitate is introduced into a platinum crucible, putting in also the rolled up filter, the crucible is covered, and heated till the filter is carbonised. It is then placed in a slanting position in the flame of a Bunsen burner for ten minutes, and is afterwards ignited before the blast for five minutes, let cool in the desiccator, and weighed.

The concentration of the solutions to be employed is as follows:—

1. Molybdic solution.—150 grms. ammonium molybdate is dissolved with water so as to make 1 litre, and poured into 1 litre nitric acid of specific gravity 1·2.

2. Concentrated solution ammonium nitrate.—750 grms. ammonium nitrate dissolved with water to the bulk of 1 litre.

3. Dilute solution ammonium nitrate.—100 grms. ammonium nitrate dissolved in water to the bulk of 1 litre.

4. Magnesia mixture.—55 grms. crystalline magnesium mixture and 70 grms. ammonium chloride are dissolved in 1 litre ammonia at 2½ per cent.

The process differs in three points from that commonly followed:—

1. The precipitation and washing of the molybdic precipitate is executed in presence of ammonium nitrate, for the practical purpose of economising time, and molybdic and nitric acids.

2. The authors rinse the precipitate from the perforated filter with ammonia at 2½ per cent, and add the magnesia mixture at once, whilst generally the precipitate is dissolved on the filter with heated concentrated ammonia, the ammoniacal liquid is neutralised with hydrochloric acid, the liquid, which is thus heated, is allowed to cool, then mixed with magnesia mixture, and finally diluted by one-third with ammonia. This modification of the common process is recommended for practical reasons.

3. The magnesia mixture is added drop by drop, and with continual stirring, whilst other instructions are silent on this head. These precautions are given because otherwise an impure precipitate and an excess of phosphoric acid are obtained.

As regards the first point, E. Richters demonstrated ten years ago that the separation of the molybdic precipitate, which is interfered with by the presence of much acid and certain salts, *e.g.*, potassium and sodium sulphates, is greatly facilitated by the addition of ammonium nitrate. This recommendation is also given by Gilbert. The authors have found, in an especial series of experiments, that a much smaller excess of molybdic solution suffices if ammonium nitrate is present.

They have also found experimentally that the application of a heat of 80° and a rest of one hour will suffice to effect the precipitation of all the phosphoric acid. If the temperature exceeds 90°, free molybdic acid separates out, which does not readily dissolve in ammonia, and is therefore troublesome.

The molybdic precipitate is insoluble both in dilute molybdic solution and in a 15 per cent solution of ammonium nitrate slightly acidulated with nitric acid. Hence this mixture may be safely used for washing the precipitate, even without the addition of molybdic solution. But the authors find, further, that a 10 per cent solution of ammonium nitrate gives satisfactory results, even without acidulation with nitric acid, and this accordingly they recommend.

The reason for the direct addition of magnesia mixture to the ammoniacal solution of the molybdic precipitate is as follows: The simple rinsing the precipitate from the filter, and washing the paper with dilute ammonia, is much more easily and readily effected than dissolving the precipitate upon the filter with hot ammonia followed up in the ordinary manner, by which, further, too much ammonium chloride is often formed.

As regards the third point the authors have previously pointed out that a sudden addition of magnesia mixture occasions an impure precipitate. A pure precipitate and an accurate result can be obtained only by a very gradual addition of the magnesia mixture with constant stirring.

There remain only three questions:—

1. In how far is the degree of concentration of the solution of influence in precipitation with magnesia mixture? The experimental reply is that it may safely vary within wide limits.

2. How long must the solution be let stand, after the addition of the magnesia mixture, before it can be filtered? The results of the authors, in accord with those of Abesser, Jani, and Märcker, show that it is not merely unnecessary to allow the mixture to stand twelve to twenty-four hours, as was formerly customary, but, on the average, more accurate results are obtained (supposing a quantity of phosphoric acid exceeding 0·1 m.grm.) by filtering after about two hours.

3. In how far is the concentration of the ammonia used for washing of the magnesia precipitate of importance? The authors conclude that the solubility of the magnesia precipitate is so vanishingly small that there is no need to cut short the washing, as is almost always recommended.—*Zeit. Anal. Chemie*, xxi., 353.

Royal Institution.—Dr. William H. Stone will give the first of three lectures on "Singing, Speaking, and Stammering," on Saturday, February 17; and Professor Robert S. Ball will give the first of four lectures on "The Supreme Discoveries in Astronomy," on Tuesday, February 20.

ON THE PRESENT CONDITION OF THE SODA INDUSTRY.*

By WALTER WELDON, F.R.S.,
Chevalier de la Légion d'Honneur.

About a fortnight ago the *Times* spoke of the manufacture of soda by the Leblanc process as being, "to some extent, a dying industry." Although I hope to show this evening ground for believing that that industry is not going to die just yet, it has certainly for some time past been in a condition by no means satisfactory to the greater number of those whose capital is engaged in it. For manufacturers of soda by the Leblanc process recent years have been years, in very many cases of loss, and in not a few cases of disaster. Of twenty-five alkali works which were in operation in the neighbourhood of Newcastle-on-Tyne a very few years ago, only thirteen are in operation now; and of the other twelve,† not fewer than eight have been actually dismantled, in utter despair of its ever again being possible to manufacture soda in them by the Leblanc process except at an absolute loss. The alkali-making districts of Lancashire have advantages over the Newcastle district in respect alike of the price of salt, of facilities for supplying the American market, and of nearness to certain of the great English centres of soda-consumption; but, nevertheless, even in Lancashire some seven or eight alkali-works are standing idle, and but few of the others are working up to their full capacity. In Belgium, where there are five or six works which formerly made soda by the Leblanc process, matters are even worse, since in that country the manufacture of Leblanc soda has entirely ceased. The only other European countries in which the soda-industry as yet exists are France, Germany, and Austria. In these countries the soda-manufacture is protected by the import duties which are stated in the following table:—

Import Duties per Ton.

	France. Francs.	Germany. Marks.	Austria. Florins.
Soda-ash	41	25	12
„ crystals	19	15	8
Caustic soda	64	40	40
Bleaching-powder ..	35·5	30	15

—duties which, I believe, more than compensate for the greater cost of raw materials in those countries than in England; while in all these countries there is, moreover, a large demand for that by-product of the Leblanc process, hydrochloric acid. Notwithstanding that the French, German, and Austrian manufacturers of Leblanc soda have thus two very sensible advantages over their fellow-manufacturers in this country, they have, nevertheless, grave cause for anxiety; the French manufacturers, indeed, in part owing to a special circumstance which I will mention presently, having reason to regard the future, not only with alarm, but even with dismay.

From information kindly supplied to me by manufacturers in all the countries in which the soda-industry is practised, I have been enabled to draw up a statement of the pressnt total soda-production of the world, and of the proportions in which that production is divided between the Leblanc process and the ammonia process. In drawing up the following Table, I have converted all the figures supplied to me, alike those for soda-ash, those for crystals, those for caustic soda, those for bicarbonate, and those for black-ash sold as such, into terms of pure Na_2CO_3:—

Present Soda Production of the World.

	Leblanc Soda.	Ammonia Soda.	Totals.	Ammonia Soda per cent of Total Soda.
Great Britain ..	380,000	52,000	432,000	12·0
France	70,000	57,125	127,125	44·9
Germany	56,500	44,000	100,500	43·8
Austria	39,000	1,000	40,000	2·5
Belgium	—	8,000	8,000	100·0
United States ..	—	1,100	1,100	100·0
Total ..	545,500	163,225	708,725	23·0

This table shows that the total quantity of soda now being manufactured annually is nearly 710,000 tons, and that of this quantity more than 163,000 tons are produced by the ammonia process.

I need scarcely say that it is to the very rapid growth of this latter process that is mainly due that condition of the Leblanc process which I have endeavoured to indicate. Although it is now more than forty-seven years since the ammonia process was first proposed by Dyer and Hemming, it is less than seventeen years since that process was first realised industrially. As an industrial process, capable of being worked continuously and with satisfactory commercial results, the ammonia process dates only from 1866, being the year in which M. Ernest Solvay, of Brussels, began to produce ammonia-soda at works which he had established for the purpose at Couillet, near Charleroi. M. Solvay has now two other ammonia-soda works in operation,—one in France, at Varangeville-Dombasle, near Nancy, and one in South Germany, at Wyhlen, in the Grand Duchy of Baden,—and by his courtesy I am enabled to place before you the following statement of the quantities of ammonia-soda which he has manufactured in each completed twelve months from the 1st of May, 1866:—

	Tons.	
1866-67 ..	179	Couillet only.
1867-68 ..	465	
1868-69 ..	719	
1869-70 ..	940	
1870-71 ..	1,862	
1871-72 ..	2,805	
1872-73 ..	3,423	
1873-74 ..	3,980	
1874-75 ..	4,678	
1875-76 ..	5,768	Couillet and Dombasle.
1876-77 ..	11,579	
1877-78 ..	19,247	
1878-79 ..	25,023	
1879-80 ..	32,326	
1880-81 ..	42,669	Couillet, Dombasle, and Wyhlen.
1881-82 ..	53,400	

These figures come down to the 30th April last. Since that date, however, M. Solvay has increased his production by nearly 60 tons per day, or 21,000 tons per annum, so that he is now making ammonia-soda at the rate of very nearly 75,000 tons a year. He is thus making ammonia-soda on nearly three times the scale on which he was making it four years ago, and on nearly twice the scale on which he was making it only two years ago. In France and Germany, M. Solvay's great success has tempted other manufacturers into the field, and, although none of them are as yet large makers, their total production amounts to fully 35,000 tons per annum, raising the total Continental production of ammonia-soda to about 110,000 tons per annum, out of a total production by both processes of 275,000 tons. Of the total soda now being made on the Continent, therefore, about 40 per cent is being made by the ammonia process. While the quantity of Leblanc soda made in France has neither increased nor diminished during the last few years, the quantity of Leblanc soda made in Germany and Austria has increased by several times the quantity formerly made in Belgium;

* A Paper read before the London Section of the Society of Chemical Industry, at the Chemical Society's Rooms, Burlington House, London, Monday, January 8, 1883, by the Chairman of the Section.

† The quantity of salt decomposed in these twelve works was about 67,000 tons a year. The quantity decomposed in the thirteen works still in operation is about 220,000 tons a year.

so that not only these 110,000 tons of ammonia-soda per annum, but also fully 25,000 tons per annum of Leblanc soda, have been added, comparatively recently, to the soda production of the Continent: going partly to supply increased consumption, but largely to diminish importation from England. And of this vast increase in the Continental production of soda,—four-fifths of which increase is due to the ammonia process,—two-thirds have sprung into existence within the last five years, and a large part of those two-thirds within only two years.

In England, within the last two years, the production of ammonia-soda has been nearly trebled. The ammonia process is practised in this country as yet only by one firm. In 1873 it was not in operation in this country at all. In that year our Honorary Foreign Secretary, Mr. Ludwig Mond, arranged with M. Solvay for the right to work under his patents in this country, and in the following year, in conjunction with Mr. J. T. Brunner, Mr. Mond began to make ammonia-soda at Winnington, near Northwich. Messrs. Brunner and Mond began on a very modest scale, their production in 1875 not exceeding 2500 tons; but in 1878 their production rose to 10,000 tons; in 1880 it was 18,800 tons; and it is now at the rate of not less than 52,000 tons per annum, or at very nearly three times the rate of only two years ago.

The competition of the ammonia process with the Leblanc process has thus attained its present degree of seriousness only very recently indeed. It has come upon the makers of the Leblanc soda almost like a thunderbolt out of a clear sky.

And, serious as that competition is already, it is about to become even more serious still. Not only is it to be expected of the existing ammonia-soda works that those of them which have recently so greatly increased their production will go on increasing their production, and that those of them which have more recently started will grow as the older ammonia-soda works have grown, but new ammonia-soda works are being built. M. Solvay, who has already, as I have said, a work in operation in South Germany besides his French and Belgian works, and who is already by far the largest soda-maker in the world, will soon have a work in operation in North Germany also, at Bernburg, near Stassfurt; and he is now, moreover, erecting a work in Russia, and also a work in the United States, and is on the point of commencing the erection of a work in Austria, so that by-and-bye he will be making soda in no fewer than seven distinct works, in six different countries. In addition to all this, a large work to make ammonia-soda, not on M. Solvay's system, but on a system modified from that practised at Dieuze, is being erected near Stassfurt by the Company of Buckau; an ammonia-soda-work is building, and will be started in the spring, at Favorznow, near Cracow; and one is about to be built at Siebenburgen, in Transylvania,—not to speak of the intention of Messrs. Bell Brothers to build an ammonia-soda work at Middlesbro'. The new works which are thus in course of construction, and some of which are nearly completed, will throw on the market more ammonia-soda, to the extent of not less, from the commencement, than from 65,000 to 70,000 tons a year.* For Leblanc soda-makers, it is thus as though ammonia-soda had latterly rained from the skies during two days out of every three, and the showers were now on the point of becoming continuous.

While face to face with so serious an amount of competition, actual and imminent, on the part of the ammonia process, the Leblanc process pure and simple is now further threatened with what is surely the "most unkindest cut of all," namely, with competition from the Leblanc process itself—combined with the extraction of copper from Spanish pyrites.

To explain how this has come about, I must remind you that the sulphuric acid used in the Leblanc process is now invariably manufactured from the sulphur of pyrites; that the pyrites used in this country is now almost exclusively either Spanish or Portuguese pyrites, containing two to three per cent of copper and very small quantities of silver and gold; that after most of the sulphur has been burnt off from the pyrites, as the first step in the manufacture of sulphuric acid, the residual "burnt ore," or "pyrites cinders," as it is called, is treated by the wet way for the extraction from it of copper, and in most cases now of gold and silver also;* and that what remains when these have been extracted is an almost pure oxide of iron, which finds a ready sale for use for various purposes in connection with the manufacture of iron and steel. The supply of this cupreous pyrites is for the most part monopolised by three great companies—the Tharsis Company, the Rio Tinto Company, and Messrs. Mason and Barry. These companies not only supply nearly the whole of the pyrites used in the manufacture of sulphuric acid in England, but the Rio Tinto Company also supplies annually some 60,000 tons of pyrites to Germany, and is also beginning to send pyrites into Austria. None of the three Companies, however, has been able to sell an ounce of pyrites in France.

The reason of this is that in France itself there are two large deposits of pyrites, both belonging to soda-makers; one belonging to the Compagnie de St. Gobain, and the other to MM. Pechiney et Cie. Each of these companies itself uses its own pyrites; and the former of them supplies with pyrites the greater number of the other alkali-makers in the North of France, while the latter supplies with pyrites all the other alkali-makers of the South of France. It has obviously been impossible to sell Spanish pyrites to either of the two great soda-making firms, each of which thus has pyrites, and by no means dear pyrites, of its own, and each of which is a large seller of pyrites to other soda-makers; and the other French soda-makers, for the most part, have been precluded from even considering the question of changing to Spanish pyrites, if only by reason of the French habit of contracting for the supply of raw materials over very long periods. A French manufacturer's contract for raw materials is generally a contract for fifteen years; and most of the French soda-makers are now obtaining their pyrites under contracts which have yet a considerable time to run.

Under these circumstances the Rio Tinto Company has taken a remarkable step. To understand the motive to this step, it must be borne in mind that while French pyrites does not contain copper, and so has scarcely any value beyond that of the sulphur which it contains, Spanish pyrites has a considerable value in addition to its sulphur value. While the value of Spanish pyrites for the sulphur in it is equal to that of the best non-cupreous pyrites, its value for copper is greater than its value for sulphur, and, not to speak of its value as regards precious metals, it has also a considerable value for its iron. In this country, the cinders left after as much as possible of the sulphur of non-cupreous pyrites has been burnt off are considered to have no value at all; and even in France—where the import duty on cast-iron is greater than the present price of Glasgow pigs, and where all forms of iron are therefore appreciably more valuable than in this country,—the cinders of non-cupreous pyrites are not worth more than three francs per ton. They always contain sulphur, and sometimes contain phosphorus. The cinders of cupreous pyrites, before treatment for the extraction of copper from them, also contain sulphur, and in larger

* As no complete list of ammonia-soda works has yet been published, it may be interesting here to give one. The following list includes all the works now actually in operation:—England:—Winnington, Sandbach. Germany:—Wyhlen, Duisburg, Inowrazlow, Grevenberg, Dieuze, Trotha, Heilbronn, Nürnberg, Rothenfelde. France:—Dombasle, Giraud, Sorgues, St. Denis, Lille. Belgium:—Couillet. Austria:—Boszko. United States:—Bay City. Ammonia-soda works are now being built in the following localities:—Austria:—Favorznow, Siebenburgen, (?). Russia:—Beresniki. Germany:—Stassfurt, Bernburg. United States:—Syracuse. There is a reason why the locality of the work which M. Solvay is about to build in Austria may not yet be published.

* A German analysis of Rio Tinto pyrites gives the following results per 1000 kilos:—Sulphur, 495 kilos.; iron, 430 kilos.; copper, 30 kilos.; lead, 10 kilos.; silver, 26 grms.; gold, 180 m.grms.; bismuth, 150 grms.

quantity than the cinders of non-cupreous pyrites; but the treatment to which they are subjected for the extraction of their copper removes the whole of their sulphur, and also the whole of their phosphorus, if they have contained any, leaving a residual oxide of iron of great purity. This residual oxide, or "purple ore," as it is called, now sells in this country for twelve shillings per ton, and in France it would doubtless command a higher price.

Now, in this country a state of things has grown up under which the manufacturers of Leblanc soda derive no advantage from the value for copper and iron of the pyrites which they employ. The treatment of the cinders of cupreous pyrites has become in this country a separate industry, practised only in a few instances by alkali-makers themselves, but practised for the most part by Companies or individuals who do not themselves make soda, but who either buy from soda-makers the cinders of pyrites of which the soda-makers have bought both values, the copper value as well as the sulphur value, or themselves buy both values, selling only the sulphur value to the soda-makers, or else buy direct from the pyrites sellers the copper value only: the pyrites sellers in such cases selling the copper value of their pyrites to one purchaser and its sulphur value to another. It is an industry which yields fair commercial profits, so that soda-makers may be incurring actual loss, while those who deal with the cinders of the pyrites from which the soda-makers have burnt off sulphur are at least making a living. And while the treatment of the cinders of Spanish pyrites is fairly profitable in this country, the greater value of iron and iron ores there than here would doubtless render it more profitable in France. It is true that coal is more costly in France than in England; but the quantity of coal required for treating pyrites cinders is not great.

The course, then, which the Rio Tinto Company is taking is this. Unable to sell its pyrites to the French Leblanc soda-makers, it has determined that the Leblanc soda made in France, or at least a large part of it, shall nevertheless be made by means of Rio Tinto pyrites, and to this end it has promoted a subsidiary company, "La Compagnie d'Exploitation des Minerais de Rio Tinto," which Company is to make Leblanc soda in France and elsewhere, relying for its profits neither on soda nor on chlorine, but on copper and oxide of iron. For this company, soda and chlorine will be simply by-products, which it will be glad to sell at a profit, if that may be, but which, if that may not be, it will be content to sell at the bare cost of manufacturing them. It will manufacture them only for the sake of converting Rio Tinto pyrites into pyrites cinders.

This new company proposes to operate upon an enormous scale. It has a capital of £1,200,000 sterling, of which one-half is already paid up, and there is talk of its building in France no fewer than five great works: one of which, designed, and to be managed, by Englishmen, it has already commenced, in the neighbourhood of Marseilles. The result cannot but be very grave for the existing French Leblanc soda-makers, and must inevitably affect the makers, both of Leblanc soda and of ammonia-soda, in this country also.

Moreover, this new company will not confine its operations to France. Not only will it take Spanish pyrites to the United States, and there make sulphuric acid, extract copper, and obtain "purple ore"—large quantities of which at present go from England to America,—but it will also build a large soda-making and copper-extracting work,—which will certainly affect the English alkali trade,—in the neighbourhood of Antwerp. The Leblanc process will thus be re-introduced into Belgium, not as a substantive process, but simply as a part of a combination of processes for the utilisation of cupreous pyrites.

To such complexion has the Leblanc process come at last. Originally, soda was its only commercial product, the hydrochloric acid produced during the first stage of it being turned to no account. In time a demand grew up for chlorine, that hydrochloric acid began to be utilised, and the manufacturers of Leblanc soda now sent into the market two products, by each of which they gained profits. Then their soda ceased to be profitable, and became a kind of by-product, which they continued to make only because they could not otherwise make chlorine. Now, Leblanc soda gives no profit at all, and chlorine none to speak of; and both have come to be regarded as secondary products, to be made only incidentally, and only because making them is essential to the application to certain ores of the wet method of extracting copper.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 1, 1883.

Dr. Gilbert, F.R.S., President, in the Chair.

The minutes of the previous meeting were read and confirmed.

The following certificates were read for the first time:—G. Board, J. J. Knight, J. O'Sullivan, A. Vasey, T. D. Watson, R. M. Walmsley.

During the evening a ballot was held, and the following were declared by the Scrutators, Messrs. J. Spiller and W. Thorp, to be duly elected:—As Foreign Members—F. Beilstein, P. T. Cléve, H. Debray, E. Erlenmeyer, R. Fittig, H. Helmholtz, D. Mendeleeff, Victor Meyer, Lothar Meyer. As Ordinary Fellows—H. C. Bond, G. Chandra Basu, J. Brock, A. M. Chance, J. T. Donald, H. C. Foote, W. Fox, W. R. Flett, J. A. M. Fallon, E. C. Gill, F. Gothard, J. Hunter, H. Jones, R. B. Lee, A. H. Jackson, Joowansinghi, T. Jenner, J. E. Johnson, W. W. J. Nicol, F. W. Richardson, E. S. Spencer, C. A. Serré, J. Turner, J. E. Tuit.

Dr. Hodgkinson then communicated to the Society a paper "*On Derivatives of Fluorene*," by W. R. E. Hodgkinson and F. E. Matthews. Since Berthelot first isolated diphenylen-methane from coal-tar oil, this body—termed fluorene from its supposed fluorescent properties—has been studied by several chemists. The object of the present investigation was to obtain a hydroxy derivative. The fluorene was obtained in a state of approximate purity from Schuchardt and Kahlbaum. It was crystallised five or six times from hot alcohol, those crystals only being reserved which fell out between 25° to 30°, and thus a pure product, melting constantly at 113° and boiling at 298° to 305°, was obtained. The slight fluorescence of this pure product can be entirely removed by sublimation over a little potassium carbonate. A dibrom-fluorene, $C_{13}H_8Br_2$, and a monobrom-fluorene, $C_{13}H_9Br$, were obtained; both these bodies yield, on oxidation, a substituted diphenylen-ketone. The authors have also prepared fluorene-sulphonic acid, $C_{13}H_9SO_3H$, by treating a chloroform solution of fluorene with SO_3HCl; the potassium, barium, and cadmium salts were prepared and analysed. On heating the potassium sulphonate with potash to 400° C., acidifying the product, and distilling in a current of steam, a white crystalline substance came over,—consisting of a substance melting at 205°, having the composition $C_{12}H_{10}O_3$, and a second substance much more soluble in water. This extraordinary result, the formation of trihydroxy-diphenyl, can only be brought about by the splitting off of the methylen group in fluorene, and its replacement by two hydroxyl groups. By dropping the hydrocarbon into fused potash a dihydroxy-diphenyl, $C_{12}H_{10}O_2$, melting at 98°, was prepared. The authors shortly discuss the constitution of these bodies. The authors have also prepared dichlor-fluorene, $C_{13}H_8Cl_2$, by passing chlorine through a cold chloroform solution of

fluorene. By using boiling chloroform a substance, $C_{13}H_5Cl_7$, is obtained. A completely different action takes place when chlorine is passed into boiling fluorene. Fused potash acts energetically on these chloro-derivatives.

Mr. R. COWPER then read a paper "*On the Action of Chlorine on Certain Metals.*" As previously noticed by Wanklyn, dry chlorine is quite unable to act upon metallic sodium. The author finds that chlorine which has been perfectly dried by long contact with fused calcium chloride is without action on Dutch metal foil. On introducing a minute quantity of water the ordinary reaction ensues immediately. Similarly zinc foil and magnesium are not attacked. Silver and bismuth are tarnished very slowly. Tin foil, arsenic, and antimony are attacked immediately. The author remarks that these three metals all form chlorides which are liquid at ordinary temperatures. Chlorine, whether dry or moist, attacks mercury. If dried chlorine be passed over a piece of potassium the latter catches fire; this is probably caused by the envelope of hydrate. Potassium was sealed up in a tube containing dry air. The tube was then heated until all the oxygen was absorbed and a bright surface of potassium was obtained; the tube was then filled with chlorine. The surface of the metal became slowly covered with a deep purple film, and the potassium finally ignited when heated considerably above its melting-point.

Dr. ARMSTRONG suggested that the author should dry the chlorine with phosphoric anhydride, and then try its action upon antimony; it was most important to settle the question whether two bodies could act upon each other without the presence of a third: thus in most text-books it was stated that zinc dissolved in sulphuric acid; now zinc is quite insoluble in sulphuric acid, and the presence of water is necessary to effect solution.

Mr. J. SPILLER asked if the author had ascertained, in an alloy, whether chlorine attacked one metal, leaving the other untouched,—as, for instance, an alloy of zinc and tin.

Mr. GROVES said that bromine, when dry, had no action upon zinc, but acted violently upon antimony and tin.

Dr. HODGKINSON mentioned that sulphur dioxide and sulphuretted hydrogen did not act upon each other if perfectly dry.

Prof. MCLEOD said that similarly carbonic oxide and oxygen did not explode if free from moisture.

Mr. COWPER, in reply, said that he had not tried the action of chlorine upon an alloy of zinc and tin, nor upon phosphorus.

Mr. L. T. WRIGHT then read a paper entitled "*Some Notes on Hydrated Ferric Oxide, and its Behaviour with Sulphuretted Hydrogen.*" The author endeavoured to prepare hydrated ferric oxide by precipitating the chloride with ammonia, but could not succeed in preparing it free from basic chloride. In order to avoid the inconvenience of handling a bulky gelatinous precipitate, the following method was tried:—Ferric chloride solution was added slowly to an excess of ammonia, and the whole evaporated to dryness at 100°. The reddish brown mass, on treatment with water, fell into an impalpable powder, which for the most part passed through many filter-papers. The filtrates were turbid, and of a bright red colour. In this condition the precipitate is probably similar to the so-called "colloidal ferric hydrate." The ferric hydrate in this condition is not blackened by sulphuretted hydrogen. Recently precipitated ferric hydrate is blackened at once by sulphuretted hydrogen, and the sulphide thus formed is completely soluble in excess of potassic cyanide,—

$$FeS+6KCN=K_2S+K_4Fe(CN)_6.$$

Two equations are given in text-books to express the reaction of sulphuretted hydrogen upon hydrated ferric oxide:—

$$(1.)\ Fe_2O_3H_2O+3H_2S=Fe_2S_3+4H_2O.$$
$$(2.)\ Fe_2O_3H_2O+3H_2S=2FeS+S+4H_2O.$$

The author has studied the reaction, estimating the sulphur and the water formed.

Mr. PAGE suggested that it would be interesting to know whether the finely divided precipitate could be filtered off by sucking the fluid by a Sprengel pump through porous porcelain, milk when thus filtered through the porous cell of a Daniell battery furnishing a perfectly transparent filtrate, almost free from albuminous bodies and fats, but containing the sugar and salts.

The SECRETARY then read a paper "*On Alpha-cyano-naphthalene Sulphonic Acid,*" by U. K. DUTT. The author first prepares naphthalene-alpha sulphonic acid by heating naphthalene in carbon disulphide solution with sulphuric hydrochloride. The acid was converted into a potassium salt, which was distilled with an equal quantity of potassium ferrocyanide. The product was crystallised from light petroleum, and obtained as yellowish acicular crystals, melting at 36°. This α-cyano-naphthalene was dissolved in carbon disulphide and treated with sulphuric hydrochloride, and thus brilliant colourless laminar crystals of α-cyano-sulphonic acid were obtained. The barium salt was also prepared and analysed by the author.

The Society then adjourned till February 15th, when the following paper will be read:—"On some Derivatives of Diphenyl-ketone Oxide," by A. G. Perkin.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, February 5, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

THE Duke of Bedford, K.G., Lord Lawrence, Major Gerald Edmund Boyle, Mrs. Henry Bonham Carter, Joshna Fielden, Esq., Major Alexander Thomas Fraser, R.E., and Mrs. Clara E. Murchison were elected Members of the Royal Institution.

Ten candidates for membership were proposed for election.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

CORRESPONDENCE.

ALKALINE PERMANGANATE FREE FROM AMMONIA.

To the Editor of the Chemical News.

SIR,—The CHEMICAL NEWS, vol. xlvi., p. 284, contains a paper by Mr. J. Stapleton, on the difficulty of preparing alkaline permanganate free from ammonia. I have found that the method advocated by the Water Committee of the Society of Public Analysts yields a product as pure as that of your correspondent, provided *recently-distilled* water be used in its preparation.

A few days ago I determined the amount of ammonia in some permanganate solution that has been made for *more than two years* (and which I have used for purposes of instruction in water analysis only). When distilled with perfectly pure water it yielded but 0·01 m.grm. per litre. When tried with the ordinary distilled water used in the laboratory (after distilling off free NH_3), it yielded 0·04 m.grm. per litre, showing the effect of dust in the water.

I think it is quite as necessary to pay attention to the preparation of the Na_2CO_3 solution as to the permanganate.—I am, &c.,

A. PERCY SMITH.

Temple Observatory, Rugby
February 2, 1883.

INSOLUBILITY OF AMMONIO-MAGNESIA PHOSPHATE IN DILUTE AMMONIA.

To the Editor of the Chemical News.

SIR,—In a communication to the CHEMICAL NEWS, vol. xlvii., p. 9, Mr. David Lindo, has noticed that I make no allowance for the solvent action of dilute ammonia upon ammonio-magnesia phosphate in my paper upon the "Estimation of Phosphoric Acid as Magnesic Pyrophosphate," published in the CHEMICAL NEWS, vol. xlvi., p. 213.

The rejection of such allowance was made with a full understanding of the subject, and I am glad to avail myself of the present opportunity of reviewing the history of this matter.

In his "Anleitung zur Quant. Anal.," 5 Aufl., 333, Fresenius recommended an allowance of 0·001 grm. $Mg_2P_2O_7$ for every 54 c.c. of mother-liquor and of washings employed in estimating P_2O_5 by precipitating as ammonio-magnesia phosphate.

Very seldom have the need of the utmost certainty on the part of one recognised as authority in any department of science, and the mischievous results of a single error on his part, been better illustrated than in this particular case, for, though in the very next edition of the same work, Fresenius himself withdrew this allowance, and, though it has been shown to be wholly incorrect again and again by careful experimenters, yet the allowance still lives a vigorous life in many quarters.

The facts in regard to the case seem to be as follows:—

1. That while ammonio-magnesia phosphate is soluble to a small extent in dilute ammonia containing a very large amount of ammonium chloride

2. This solubility is decreased (*a*) by the absence of an ammonia salt, (*b*) by the presence of an excess of magnesia salt, and (*c*) by an increase in the amount of ammonia present, until it becomes so slight as to be for all practical purposes absolutely nothing.

The grounds for this opinion may be briefly stated as follows:—

I. In my own experiments upon this subject, when the first precipitates were dissolved in HCl and again precipitated, and when consequently only the minutest traces if any of retained impurities could be present, and when the precipitates were exposed to the solvent action of at least 400 c.c. of ammonia water, yet the amount dissolved was so insignificant as not to affect the result in the slightest.

II. A series of experiments made by Kubel (*Zeit. für Anal. Chemie*, viii., 125) in the same way, with the exception that the precipitates were *twice* dissolved and re-precipitated, gave 99·80 per cent of the theoretical amount, and, when *three times* dissolved and re-precipitated, gave 99·2 per cent. Remembering that in these cases there is present a considerable amount of ammonium chloride (which increases the solubility of the precipitate), and noticing how extremely small was this solubility, even under such unfavourable conditions, it can readily be understood how this solubility becomes a *vanishing* quantity when there is only a trace of ammonium chloride present (coming from the small amount in the magnesia mixture employed as a precipitant), when the salt is exposed to only *one* precipitation and washing, instead of *four* as above, and where the ammonia wash-water used is very strong, as in the method of procedure most highly recommended by me in the article referred to.

III. As other authorities on this point may be quoted, Abesser, Jani, and Maercker (*Zeit. f. Anal. Chem.*, xii., 239); Gooch (*Amer. Chem. Journal*, i., 391), who makes no allowance for the alleged solubility in question, and yet after double precipitation obtains accurate results; and finally, as the latest and most exhaustive treatise on this whole subject, I refer to the paper of Stünkel, Wetzke, and Wagner (*Zeit. f. Anal. Chem.*, xxi., 353),—a paper which you will pardon me for hoping will soon be translated and published in the CHEMICAL NEWS,* because of the value and accuracy of the methods there recommended. These last authors there demonstrate that when used for washing the ammonio-magnesia-phosphate precipitate—

1000 c.c. 1 per ct. ammonia water dissolve 0·88 grm. P_2O_5
1000 c.c. 2 " " " " 0·23 " "
1000 c.c. 3 " " " " 0·15 " "

As in my work I used about 200 c.c. of mother-liquor and wash-water combined, composed of 1 part strong ammonia liquor to 3 parts water, the absolute insignificance of any solvent action can be seen at once.

Our experience since the publication of my paper leads us to believe more positively than ever that the gradual addition of the magnesia mixture, at the rate of one drop a second, to the solution of phosphate, accompanied by constant stirring, brings down an exceedingly fine precipitate, perfectly free from any trace of retained impurity, which practically is absolutely insoluble in strong ammonia water.

Hoping that your publication of this review will assist in laying this unhappy ghost so long detained after sunrise from its proper resting-place,—I am, &c.,

THOMAS S. GLADDING.

Laboratory of Stillwell and Gladding,
New York.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 3, 1882.

Determination of Sulphurous Acid in Air.—B. Proskauer.—The author passes a known volume of air through 50 or 75 c.c. of a solution of permanganate containing 15 grms. of the crystalline salt per litre. To prevent the formation of hydro-sulphurous acid, 2 or 3 c.c. of hydrochloric acid are added. The solution is placed in a Bunsen bulb-tube.

Valuation of Commercial Lead Peroxide.—H. Fleck recommends the introduction of a weighed quantity (0·5 grm.) into a standard solution of ammonium ferrous sulphate, adding not more hydrochloric acid than is required for the decomposition of the lead peroxide. After heating the liquid is diluted with boiled water cooled down to the temperature of the room, and titrated with permanganate. A better process is to decompose a weighed quantity of the sample with a sufficiency of hydrochloric acid in a small flask fitted with a gas delivery tube. The chlorine gas given off is passed into solution of potassium iodide, and the iodine liberated is estimated in the known manner with sodium hyposulphite. The moisture of the samples is found by drying at 110°.

Valuation of Citric Acid.—J. Macagno neutralises with sodium carbonate, precipitates at a boil with calcium chloride, filters, concentrates the filtrate, and filters again hot, washing the deposit of calcium citrate with a little hot water. In old samples of lime-juice this process is untrustworthy, as fatty acids are formed by fermentation at the expense of the citric acid.

Analysis of Fats.—Nickels seeks to distinguish olive and cotton oils by means of the absorption-spectrum. E. Mylius points out that the absorption-bands belong not to olive oil as such, but to the chlorophyll dissolved in it, and are either very faint, or absent in the finest qualities. Crude cotton oil has the specific gravity 0·9303 at 16°, the

* This paper appears in our present issue, p. 66.—*Ed.* C. N.

refined oil 0·92647 at the same temperature (or according to Scheibe and De la Souchère, 0·923 at 17°), whilst olive oil is at 17° 0·915 to 0·916, or, according to Scheibe, 0·912. According to De la Souchère, cotton oil can be detected in mixtures by the more or less intense coffee-brown colour which the oil in question assumes when shaken up with an equal volume of nitric acid of specific gravity 1·37. According to Rödiger, cotton oil contains a non-saponifiable ingredient, which can be extracted by benzol from the dry soap in the form of golden yellow drops. For the detection of sesame oil in olive oil De la Souchère adds to a small piece of sugar hydrochloric acid of specific gravity 1·18. Equal quantities of this mixture and of the oil are shaken up together. The smallest quantities of sesame are betrayed by a red colouration.

New Method for the Analysis of Oils.—E. J. Maumené.—From the *Comptes Rendus.*

Forms which Drops of Different Fats assume.—A. Wynter Blyth.—From the *Analyst.*

Determination of Neutral Fat, Palmitic and Oleic Acids in Palm Oil.—Fr. Sear.—From the CHEMICAL NEWS.

Determination of Undecomposed Fats in Mixtures of Fatty Acids.—O. Hausamann.—The author dissolves 5 grms. of the fatty acid mass in question in alcohol, adds 1 to 2 drops solution phenol-phthaleine, and titrates with alcoholic normal alkali till a red colour appears. An excess of normal alkali may be added, and the mixture may then be titrated back with normal oxalic acid till the redness disappears. The number of c.c. of normal alkali consumed may be, *e.g.*, 17·0, which correspond to the free fatty acid present. The weight of the latter, being a mixture of stearic, palmitic, and oleic acid, cannot be calculated until the molecular weight of the mixture is established. For this purpose 5 grms. of the mass are heated in the water-bath along with 25 c.c. of alcoholic normal alkali until quite dissolved, thus saponifying the neutral fat simultaneously with the free fatty acid. This mixture is then titrated back with normal oxalic acid. Assuming that 6·7 c.c. of the normal acid have been used, 18·3 c.c. of the normal alkali would have served for the neutralisation of the free fatty acid and of neutral fat. But 18·3 c.c. of normal alkali corresponds to 5 grms. of the mixture of fatty acid; 1000 c.c. would represent 273·2 grms., which last number may be regarded as the molecular weight of the mixture. But 5 grms. of the mass require 17·0 c.c. of normal alkali, therefore they contain $17 \times 0{\cdot}2732 = 4{\cdot}644 = 92{\cdot}8$ per cent fatty acid, and 7·2 per cent neutral fat. The method is applicable to the determination of non-saponified fats in soaps.

Examination of Turkey-red Oil (Alizarin Oil).—L. Brühl introduces a weighed quantity of the sample into a graduated cylinder, and shakes it up first with dilute sulphuric acid and then with ether. The latter dissolves the sulpho-ricinoleic acid, the weight of which is taken after the evaporation of the ether.

Examination of Soda Soap.—Hope.—From the CHEMICAL NEWS.

Examination of Petroleum.—J. Schenkel.—A petroleum which gives off more than 5 per cent of volume below 140°, and more than 10 per cent below 300°, is to be rejected. The commercial value of petroleum is determined by the volume percentage which distil over between 145° and 300°. The petroleum which distils over between these two limits is considered as normal petroleum.

Analysis of Explosive Ethers.—F. Hess.—Not suitable for abstraction.

Analysis of Photographic Emulsions of Gelatine and Collodion.—J. M. Eder.—This memoir cannot be usefully abridged.

Detection of Fusel Oil in Alcohol.—Hager dilutes the alcohol, if containing more than 60 per cent of absolute alcohol, with an equal volume of water, adds glycerine, and lets evaporate upon filter-paper. After the escape of the alcohol the fusel odour becomes distinct. The author also gives instructions for the quantitative determination of fusel oil.

Determination of Sugar.—F. Böckmann.—An account of the methods of determination and conditions of sale adopted in the French and Belgian beet-root works.

Detection of Mineral Acids in presence of Organic Acids.—A. Joussien mixes in a dry test-tube a drop of the essential oil of Dipterocarpus, with 25 drops of glacial acetic acid. The mixture is colourless, and remains so on the addition of any organic acid. But if a trace of a mineral acid is present there appears a rose colour, which passes into violet, and does not disappear on the addition of 30 drops of alcohol.

Determination of the Total Alkaloid in Cinchona Barks or Cinchona Preparations.—This paper requires the accompanying figure.

The following analytical methods referring to physiology, pathology, and forensic chemistry can be merely named:—

Determination of Magnesia in Urine by Titration.—MM. Neubauer, Stolba, Kraus.

Detection of Lead, Silver, and Mercury in the Animal Body.—Victor Lehmann.

Determination of Oxalic Acid in Urine.—F. Czapek.

Urines Coloured Red by Ferric Oxide.—B. Tollens and R. v. Jaksch.

A New Pathological Urine Pigment.—E. Neusser.

Detection and Determination of Arsenic in Organic Masses.—R. H. Chittenden and H. H. Donaldson.—From the *American Chemical Journal.*

Reduction of Arsenious Acid or Arsen-Sulphide.—C. Brame.—From the *Comptes Rendus.*

The General Distribution of Copper in the Animal and Vegetable Kingdoms.—G. L. Ulex.

Detection of Phosphorus in Urine.—F. Selmi.—From the *Monitcur Scientifique.*

The Infusoria as Physiological Tests for Poisons.—N. J. Rossbach.

Detection of Spermatozoa.

Cosmos Les Mondes.
No. 2, January 13, 1883.

Colour of Distilled Water.—M. Meyer.—The author takes a glass tube 7½ metres long and 4 c.m. in diameter, closed at each end by parallel planes of glass. This apparatus is filled with distilled water, and placed horizontally. On looking through it at a black ground by daylight the colour appears intensely blue; by gaslight, on the contrary, the colour is green.

The Atomic Weight of Lithium.—Dr. D. Tommasi.—The atomic weight of lithium as deduced from its principal compounds has been found=7, a value quite in accord with the law of Dulong and Petit. The physical and chemical properties of this metal having a certain analogy with those of the alkaline metals, chemists have not hesitated to place it in the same family with potassium and sodium, and to regard it as a monovalent metal. If it is true that free lithium resembles the alkaline metals its compounds have no analogy with the salts of potassium and sodium, but, on the contrary, approximate to the salts of the bivalent, alkaline-earthy metals, and in particular to those of magnesium. One of the most obvious characters of the alkaline sulphates is to form alums with aluminium sulphate, but lithium sulphate does not form an alum. The alkaline sulphates can form bisulphates, but lithium sulphate does not. The alkaline carbonates are readily soluble in water, whilst lithium carbonate is very sparingly soluble. Lithium chloride, unlike the

alkaline chlorides, is readily decomposed if heated in contact with air. The author, therefore, maintains that the atomic weight of lithium in its compounds is double that which it possesses in a free state. Hence he proposes for lithium chloride the formula Cl_2Li. He proposes to verify his theory by means of the law of Raoult, who has found that a molecule of any compound whatever, when dissolved in 100 mols. of any liquid whatever of a different nature, lowers the point of congelation by a quantity which is almost constant, and which approximates to 0·62°.

Currents produced by the Nitrates in Igneous Fusion in Contact with Carbon Heated to Redness.—M. Brard.—Already noticed.

Glass Coffins in Relation to Public Health.—Dr. A. Mayer.—The author proposes solid glass coffins, which, after the introduction of the corpse, are to be closed air-tight with cement. Two apertures are provided, through one of which carbonic acid is introduced, whilst the atmospheric air escapes by the other. When the coffin is supposed to be filled these apertures are sealed up.

No. 3, January 20, 1883.

According to the *Journal d'Hygiène*, organic bodies may be preserved indefinitely by a galvano-plastic process. The objects are first steeped in an alcoholic solution of silver nitrate, wiped, exposed to hydrogen sulphide or phosphide, and then immersed in the ordinary galvano-plastic bath.

No. 4, January 27, 1883.

Illumination of Balloons.—For this purpose M. Mangin, member of the "Academy of Aerostation," uses an incandescent light immersed in a beaker of water.

MISCELLANEOUS.

Poggendorff's Biographical Literary Dictionary.—Dr. W. Feddersen has issued the following circular concerning the continuation of Poggendorff's Biographical Literary Dictionary:—

"Having been commissioned by the publisher, Mr. Johann Ambrosius Barth, of Liepzig, to continue and supplement the "Poggendorff's Biographisch Literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften," I now feel obliged—in consequence of a printed declaration, which shortly the publishing-house has sent to several scientists who were interested in the work—absolutely to withdraw from all connection with it. Should the publishing-house be able to find another competent editor, I will place at its disposal, without any compensation, for my labours all the answered blanks, notices, and papers which I have hitherto received, unless the authors of them otherwise order. My own manuscript, however, I do not feel at liberty to submit in this manner, no matter whether compensation is offered or not, because I do not know whether another will conduct the work as I would have desired to, or according to the plan I have hitherto pursued, and also because I do not wish to be held responsible for any injury which may result from this editorial change. In submitting this information to those interested, I beg leave to thank most sincerely all those gentlemen, both at home and abroad, who have assisted me up to the present time, and I wish especially to recognise most gratefully the numerous personal favours I have received in the conduct of the work.—Leipzig, January, 1883.

Glycerin in Beer.—Carl Amthor.—The greatest discrepancies prevail among accepted authorities as to the amount of glycerin naturally present in beer, the proportions stated ranging from 9 per cent to 0·005. According to the author's experiment the natural maximum is 0·3 per cent.—*Zeitschrift für Analytische Chemie.*

MEETINGS FOR THE WEEK.

Monday, Feb. 12.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field.
Tuesday, 13th.—Royal Institution, 3. "Primæval Ancestors of Existing Vegetation," by Professor W. C. Williamson.
—— Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8. (Anniversary).
Wednesday, 14th.—Society of Arts, 8. "The Society of Arts Patent Bill, and some Points in American Patent Law and Practice bearing thereon," by Sir Frederick Bramwell, F.R.S.
—— Microscopical, 8. (Anniversary).
—— Pharmaceutical, 8.
Thursday, 15th.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
—— London Institution, 7.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
—— Chemical, 8. "On some Derivatives of Diphenyleneketone Oxide," by A. G. Perkin.
Friday, 16th.—Royal Institution, 8. "Anomalous Forms of Primæval Vegetation," by Prof. Williamson, at 9.
—— Geological, 8. (Anniversary).
—— Society of Arts, 8. "Overland Commercial Communication between India and China, via Assam," by Charles H. Lepper.
Saturday, 17th.—Royal Institution, 3. "Singing, Speaking, Stammering," by Dr. W. H. Stone.

FIRTH COLLEGE, SHEFFIELD.

The Council of Firth College, Sheffield, are prepared to appoint a Professor of Chemistry. The stipend will be £150 per annum, and half the fees of his own Department. Candidates are requested to give full particulars concerning age, experience, and any academical distinctions they may have gained. The names of three gentlemen to whom references may be made should be given, but no testimonials need be sent unless they are asked for. Applications to be sent in on or before March 1st.—Further particulars may be had from

ENSOR DRURY, Registrar.

Firth College, Sheffield,
January 31, 1883.

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TO BE SOLD BY AUCTION, by Messrs. Eddison and Taylor, at the Queen Hotel, in Huddersfield, on Tuesday, the 20th February, 1883, at 6 for 7 o'clock in the evening, subject to conditions of sale, and in one lot or otherwise, as may be determined upon.

For further information, catalogues of the Plant, and leave to view, apply to the Auctioneers, High Street, Huddersfield, or to

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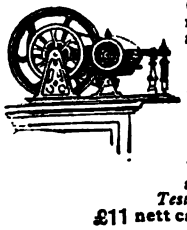

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1212.

ON THE

DETERMINATION OF NITROGEN IN MIXTURES CONTAINING NITROGENOUS ORGANIC MATTER, AMMONIACAL SALTS, AND NITRATES.

By H. H. B. SHEPHERD, F.I.C., F.C.S.

The presence of any considerable quantity of a nitrate in chemical manures and substances of a similar character, containing nitrogenous organic matter or ammoniacal salts, it is well known prevents the accurate estimation of nitrogen by the soda-lime process of Will and Varrentrap. The chief cause of failure is the disengagement of nitric acid from the nitrate, which affects the result by distilling over and increasing the quantity of acid originally placed in the nitrogen bulb, and also probably by a part combining with the free ammonia present in the combustion tube to form ammonium nitrate, which is immediately decomposed into nitrous oxide and water. The employment of copper turnings kept at a red-heat in the front of the tube will, it is true, prevent the passage of nitric acid into the nitrogen bulb, but even then an actual loss of nitrogen takes place, probably as nitrous oxide in the manner above indicated.

The quantity of hydrocarbonaceous matter present has also a direct bearing upon the result. The larger the quantity the higher will be the result obtained, owing to the reduction of a part of the nitrogen of the nitrate to ammonia. For this reason it sometimes happens that in testing a manure containing nitrogenous organic matter or ammoniacal salts or both together, as well as a nitrate, a correct determination of the organic or ammoniacal nitrogen will be accidentally obtained if much organic matter be present, since the gain on the one hand may exactly compensate for the loss on the other. But in such a case, if the determination be repeated, concordant results will not be obtained. Although this is perfectly well known, attention having been frequently directed to it, a few examples of actual results in illustration may not be out of place.

Mixture No. 1.

	Parts.	Nitrogen.
A sample of commercial sulphate of ammonia, containing 20·18 per cent nitrogen	20·41	= 4·11
Pure potassium nitrate	29·73	= 4·12
Phosphatic guano, containing 0·76 per cent nitrogen..	49·86	= 0·38
	100·00	8·61

With this mixture, which consequently contained 4·49 per cent nitrogen derived from nitrogenous organic matter and ammoniacal salts, combustions with soda-lime were made in the usual way, with the following results:—

	Nitrogen pr. ct.
12-inch iron tube used; ½ gramme sugar at the end; no copper turnings	4·27
14-inch iron tube used; ½ gramme sugar at the end; 2 inches copper turnings in front	3·68
16-inch iron tube used; 2 grammes bicarbonate of soda at the end; 4 inches copper turnings in front	4·02
18-inch iron tube used; 2 grammes bicarbonate of soda at the end; 6 inches copper turnings in front	4·52
The same repeated	3·62

Mixture No. 2.

	Parts.	Nitrogen.
A sample of commercial sulphate of ammonia containing 20·18 per cent nitrogen	20	= 4·03
Pure potassium nitrate	40	= 5·54
Calcined gypsum	40	
	100	9·57

This gave the following results:—

	Nitrogen pr. ct.
18-inch iron tube used; 1 gramme oxalic acid at the end; 6 inches copper turnings in front	2·55
The same repeated	2·20
20-inch iron tube used; 1 gramme oxalic acid at the end, and a roll of copper gauze 8 inches long in front	2·68

A sample of an actual compound manure, containing 3·07 per cent organic and ammoniacal nitrogen, and in addition 3·03 per cent nitrogen in the form of sodium nitate, on testing in the same way, using 6 inches of copper turnings, gave only 2·48 per cent. nitrogen, or a loss of of over half per cent.

There can be no doubt that the want of a ready means for correctly estimating the nitrogen in mixtures containing organic or ammoniacal nitrogen and nitrates has hitherto largely hindered manure manufacturers from employing potassium or sodium nitrate in the composition of special manures, and attempts have been made by different chemists from time to time to devise a scheme to meet the difficulty and avoid resorting to Dumas' method of combustion with copper oxide.

A process that has been used to some extent on the Continent consists in simply adding a quantity of starch or sugar to the substance for analysis before the combustion with soda-lime, so as to effect the reduction of the nitric nitrogen to ammonia; but it has been repeatedly shown that the reduction by this means is very far from complete, and consecutive determinations made with the same substance will be found to vary considerably.

In the Chemical News, vol. xxv., page 205, B. J. Grosjean suggested the following plan:—

Determine the nitric and ammoniacal nitrogen by decomposing with aluminium or iron, and solution of caustic soda in the apparatus recommended by Vernon Harcourt for nitrates. Carry on the distillation until the contents of the retort become pasty, and submit the residue to combustion with soda-lime. To obviate the difficulty of removing the residue from the retort, he further proposed to treat an equal quantity of the substance in a beaker in a similar way, carrying on the evaporation to the same point and at the same temperature as in the retort. The nitrogen obtained by combustion of the residue with soda-lime, added to that furnished by the distillation, will then give the total nitrogen.

Another plan is to expel the nitric acid contained in the substance for analysis by evaporation with sulphuric acid, and determine the nitrogen in the residue. If the percentage of nitric acid is also required a separate determination can be made in a fresh portion of the original substance.

Ruffle's Method.—A method for determining nitrogen, including the nitro-compounds, in one operation, was published by J. Ruffle in a paper communicated to the Chemical Society ("On the Estimation of Nitrogen by Combustion, including the Nitro-compounds;" *Journ. Chem. Soc.*, vol. xxxix., p. 87). This method depends, as is well known, upon the reduction of the nitro-compounds by sodium thiosulphate—the so-called hyposulphite of soda—in presence of sodic hydrate. To proceed according to Mr. Ruffle's directions there are required, besides the usual materials for performing combustions with soda-lime,—

(1.) A mixture of wood charcoal and sulphur in equal proportions.
(2.) A special soda-lime prepared by dissolving 160 grms. of sodic hydrate in 160 c.c. of hot water, and stirring in 56 grms. of finely-powdered lime obtained from marble. The mass to be then thoroughly dried and powdered.
(3.) Some common hyposulphite of soda.
(4.) Iron combustion-tubes 22 inches long and ½ inch internal diameter.

The process is conducted as follows:—

From 1 to 1½ grms. of the substance to be analysed is first mixed with 1½ grms. of the charcoal and sulphur mixture, 21 grms. of hyposulphite are crushed in a mortar, 18 grms. of the special soda-lime added, and the two well intermixed. About 5 grms. of this mixture are first passed through a funnel into the combustion-tube; then about 30 grms. of the mixture are placed in the funnel, the substance for analysis, as previously prepared, quickly mixed with it, and the whole dropped into the tube. The remaining 4 grms. of the mixture of hyposulphite and soda-lime are next poured in, followed by 18 grms. of ordinary soda-lime. Finally, the customary plug of asbestos is inserted, the bulb containing the standard acid attached, and the combustion conducted in the usual way.

As this process appeared to be a very promising one, the following experiments were undertaken to ascertain how far Mr. Ruffle's results could be corroborated:—

It was found, in the first place, that a blank experiment, *i.e.*, without any substance for analysis, gave a small but by no means insignificant quantity of nitrogen, derived partly perhaps from the charcoal, but chiefly from a trace of nitrate in the soda used for making the soda-lime. It is important to be on one's guard against this source of error, since the presence of 1-10th per cent of sodium nitrate in the caustic soda used for making the special soda-lime would yield sufficient nitrogen to introduce an error of 0·2 per cent in the results if 1 grm. of substance were taken, and this is omitting any consideration of the ordinary soda-lime used for the front part of the tube. Practically it will be found that nearly all commercial caustic soda contains a trace of nitrate, due to a slight excess being used in the process of nitrating for the destruction of sulphides, &c., in its manufacture. Caustic soda free from nitrate may, however, easily be obtained by causticising pure carbonate, or soda made from sodium may be used, but in any case a blank experiment should be made before proceeding with an actual determination. In the following experiments the error was ascertained in this way, and the amount deducted from each determination:—

The following are some results that were obtained:—

Pure ammonium sulphate containing 21·21 per cent nitrogen—

Percentage of Nitrogen found.
21·15
21·20

A sample of Puruvian guano free from nitric nitrogen—

	Nitrogen per cent.
Determined by ordinary soda-lime process	11·38
„ „ Ruffle's process	11·38

A sample of Australian phosphatic guano—

Determined by ordinary soda-lime process	0·76
„ „ Ruffle's process	0·80

Pure potassium nitrate containing 13·85 per cent nitrogen—

Percentage of Nitrogen obtained.	Calculated as Percentage of the Total Nitrogen present.
13·54	97·76
13·35	96·39
13·21	95·37
13·34	96·31
13·18	95·16

Pure sodium nitrate containing 16·47 per cent nitrogen—

15·85	96·23
16·11	97·81
16·00	97·14
15·73	95·50

It is much to be regretted that the experiments with potassium and sodium nitrate did not yield entirely accurate results; still, it must be remembered that manures very rarely indeed contain more than 4 or 5 per cent nitric nitrogen, and the nitrogen in other combinations is determined in full by Ruffle's method.

A drawback to the use of this process is the difficulty of cleaning out the iron tubes. Mr. Ruffle recommends the following plan. Remove the asbestos plug whilst the tube is still hot, and pass an iron rod (previously heated) down to the end, then withdraw it, and insert again, repeating this several times while the tube is cooling. When cold, pour in warm water, and agitate by drawing the iron rod up and down, by which means the tube can be washed clean. Though this will answer, it is a little tedious, and a quicker plan is to fix the tube, when cold, in a vice, and drill out the contents with a drill the length of the tube.

While speaking of the Ruffle process it is as well to caution anyone using it for the first time to be careful to place the tube in the furnace either in a perfectly horizontal position, or with the front slightly elevated. If this precaution is not observed the fused mass inside will gradually flow towards the front, completely blocking it, and an explosion will be inevitable.

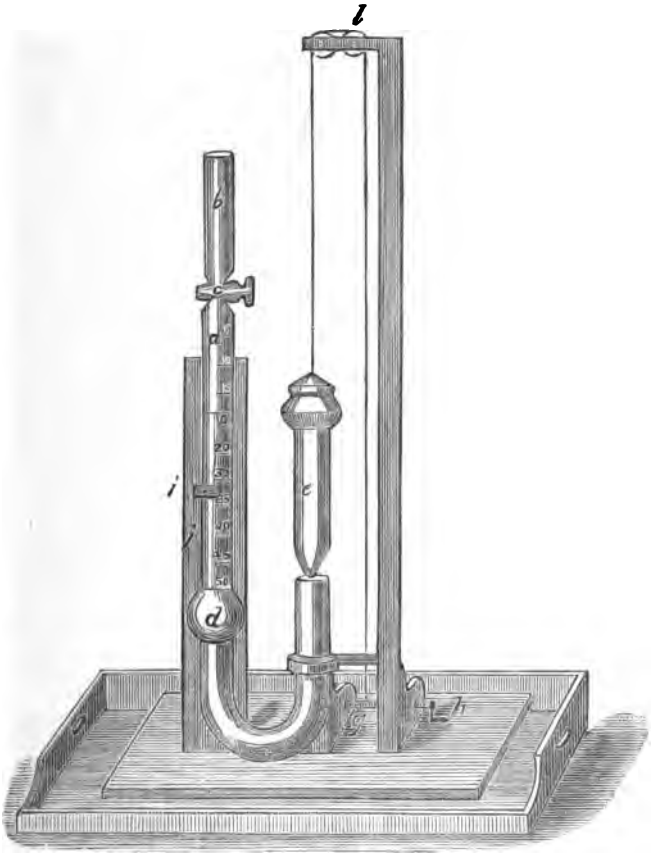
Determination of Nitric Acid in Manures.

For the determination of nitric acid in manures, the Crum and the indigo methods are both well adapted. When the quantity of nitric nitrogen present is small the indigo method can be made to yield excellent results, but in cases where a large amount is present it is better to resort to the Crum method. This method, indeed, answers admirably in all cases, leaving little or nothing to be desired.

The Crum Method.—The accompanying sketch shows a form of nitrometer and stand suitable for working Crum's method.

The cylindrical part of the nitrometer, *a*, has a capacity of 50 c.c., and is graduated in its entire length into 500 divisions. At the top is a cup, *b*, and between the cup and the cylindrical part an ordinary single-way stopcock, *c*. At the lower end is a bulb, *d*. The nitrometer is connected by means of a piece of stout caoutchouc pressure tubing with a levelling tube or reservoir, *e*. The levelling tube is hung by a cord, which passes over the pulley, *f*, and is fastened to the switch, *g*, so that by turning the handle, *h*, it can be raised or lowered. The button, *i*, serves to hold the nitrometer in its place in a recess made to fit it in the upright support, *j*. In making a determination the quantity of substance to be taken must be regulated by the amount of nitric nitrogen supposed to be present. Of substances containing as much as 5 per cent not more than 0·2 grm. should be taken, whilst of substances containing less than 1 per cent, 2 or 3 grms. will be found a convenient quantity. The weighed portion is to be extracted with boiling water and filtered, the filtrate and washings evaporated to a small bulk and passed into the nitrometer. (The removal of chlorine by silver sulphate is unnecessary.) The fluid must be kept as concentrated as possible, and including the rinsings of the evaporating basin should not exceed 5 c.c. After cooling, twice its volume of pure oil of vitriol is to be cautiously run in, and the nitrometer removed from its receptacle, and very gently shaken once or twice to mix the fluids. Usually some carbonic acid and other gases are given off, which must be allowed to escape before proceeding, by raising the levelling tube and opening the stopcock for an instant. The nitrometer is then to be very vigorously

shaken, which soon causes the evolution of nitric oxide to commence, and in a few minutes the reaction is complete. The nitrometer is then replaced and allowed to cool to the temperature of the room, the pressure equalised by raising or lowering the levelling tube and the volume of gas read off. The weight of the column of acid in the nitrometer may be compensated for with sufficient accuracy by raising the level of the mercury in the levelling tube above that in the nitrometer, about 1° for every 8° occupied by the acid—the proportion indicated by the specific gravity of the acid compared with that of mercury. (*Vide* paper by Lunge "On the Analysis of Saltpetre by the Nitrometer," *Journ. Soc. Chem. Industry*, vol. i., No. 1.) Before calculating the correction for atmospheric pressure and temperature the precaution should be taken to test



the purity of the nitric oxide by passing a warm solution of ferrous sulphate into the nitrometer, and observing if the whole of the gas is absorbed.

The Indigo Method.—The following is a brief account of the mode of working the indigo method for the analysis of manures. A standard solution of potassium nitrate is first prepared by dissolving 1·1895 grms. of the pure dry salt in a litre of water. 5 c.c. of this solution will consequently contain 0·00594 grm. potassium nitrate, or 0·003176 grm. nitric anhydride, or 0·000823 grm. nitrogen. The indigo used is either a weak solution of indigo carmine acidified with sulphuric acid, or a solution of indigotine in sulphuric acid. If indigo carmine is used, 10 grms. may be dissolved in 5 litres of water, and the solution afterwards adjusted so that 15 c.c. shall correspond to 5 c.c. of the potassium nitrate solution. The solution does not keep well, but undergoes less change if preserved from the light. To standardise it proceed as follows:—Place 5 c.c. of the potassium nitrate solution in a beaker, add 20 c.c. of water, and run in a little of the indigo from a burette; then add 50 c.c. of strong oil of vitriol, stir gently, and observe the temperature, which should rise to about 130° C. It is convenient for this purpose to use a thermometer for a stirring rod. Now quickly run in more indigo until the change of colour indicates an excess. One of the chief peculiarities of the process is that the *maximum* amount of indigo is decolourised only when it is *all* present before the addition of the oil of vitriol. (*Vide* Warrington's papers "On the Determination of Nitric Acid by Indigo," Chemical News, vol. xxv., pp. 45 and 57; *Journ. Chem. Soc.*, xxxv., 578). The result obtained by the first experiment will probably, therefore, be far short of the actual amount of indigo required. A second trial must now be made by taking 5 c.c. of the potassium nitrate solution as before, adding 20 c.c. of water, and running in *before the addition of the acid* the full quantity of indigo decolourised in the first experiment. On the addition of the 50 c.c. of acid, the colour will now entirely disappear, a further quantity of indigo being required to produce an excess. On making a third trial, running in, before the addition of the acid, the full quantity of indigo taken in the second experiment, a little more still will probably be required, and this procedure must be repeated until the maximum amount of indigo capable of being decolourised is ascertained. The following notes of an actual case will make this clear:—

5 c.c. potassium nitrate solution taken, and 20 c.c. water—

1st expt.	Indigo ran in at first	5 c.c.	Total indigo required				8 c.c.
2nd	"	"	"	8	"	"	13·9 "
3rd	"	"	"	13·9	"	"	14·5 "
4th	"	"	"	14·5	"	"	14·7 "
5th	"	"	"	14·7	"	"	14·7 "

On repeating the last-mentioned experiment several times, a mean result of 14·74 as the maximum amount of indigo required was obtained.

Several trials were then made with 10 c.c. potassium nitrate solution and 15 c.c. water, which gave a mean result of 29·45 c.c. indigo required. Therefore, since 14·74 c.c. corresponded to 5 c.c. potassium nitrate solution containing 0·000823 grm. nitrogen, each c.c. = 0·0000558 grm. nitrogen.

In testing a manure, digest 2·5 grms. in 250 c.c. water, with the addition of about 2 grms. of alum (to precipitate the organic matter). Filter and proceed exactly in the same manner as in standardising. The quantity of water to be added should be proportioned in such a way that the quantity of solution taken+water added+indigo used shall always amount to about the same volume.

The following results were obtained by the indigo method worked in this way:—

	Nitric Nitrogen by calculation.	Nitric Nitrogen found.
100 parts phosphatic guano ..		
2·5 ,, pure potassium nitrate	0·32	0·36
2·5 ,, ammonium sulphate ..		
34 ,, Peruvian guano free from N_2O_5		
10 ,, sodium nitrate	3·05	3·13
10 ,, calcined gypsum ..		

Determinations of nitric nitrogen in samples of Peruvian guano:—

	Percentage of Nitric Nitrogen found by the	
	Crum Method.	Indigo Method.
1.	0·19	0·19
2.	0·093	0·10
3.	0·65	0·66
4.	0·27	0·27

The following results will show the use of Ruffle's method for total nitrogen in conjunction with nitric acid determinations:—

		Total Nitrogen by calculation.	Total Nitrogen found by Ruffle's Method.	Nitric Nitrogen by calculation.	Nitric Nitrogen found by Crum's Method.
Commercial sulphate of ammonia with 20·18 per cent nitrogen	20·41				
Pure potassium nitrate ..	29·73	8·61	8·47	4·12	4·09
Phosphatic guano with 0·76 per cent nitrogen	49·86				
	100·00				
Pure sulphate of ammonia	2·5				
Pure potassium nitrate ..	2·5	1·55	1·55	0·32	0·35
Phosphatic guano with 0·76 per cent nitrogen	100·0				
	105·0				
Commercial sulphate of ammonia with 20·18 per cent nitrogen	20				
Pure potassium nitrate ..	40	9·57	9·44	5·54	5·53
Calcined gypsum	40				
	100				
Pure sulphate of ammonia	20				
Pure sodium nitrate ..	20	7·53	7·37	3·29	3·19
Mineral superphosphate	60				
	100				

In conclusion, the writer has much pleasure in expressing his thanks to Dr. Voelcker and Mr. Bernard Dyer for the help they have accorded him in preparing this paper.

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PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, F.G.S., late R.A.

(Continued from p. 4.)

X. Boric Acid and Aluminium Plate (*Continued*).

A. *Does all Silica Consist of Two Compounds?*

N.B.—Before commencing the subject of this paper, I take the opportunity of mentioning that, having sent a "pebble" of calcium borate (made as described in Note IX.) to Mr. Wenham, the well-known microscopist, with a view to the possible use of this substance for object glasses of microscopes, he kindly informed me that it possesses a very high index of refraction, equal, if I remember right, to that of sapphire. As, if properly made, calcium borate undergoes no alteration in any climate, and can be moulded, when hot, into any shape, taking even a higher polish than the best glass, it might be worth the while of microscopists to look into this matter.

It was stated in Note IX., that siliceous calcium borate changes weight on being re-treated in boric acid, and, if the inference—apparently the only inference—to be drawn from this phenomenon be correct, the experiment I am now about to describe seems to have scarcely a parallel in the ordinary history of chemical analysis, for simplicity of detail, combined with theoretical, and probably practical, importance of results. It is to be performed as follows:—

(1.) The operator takes up a ball or mass of pure calcium borate on a hook (not a ring as usual) of *thin* new platinum wire, about this shape ⊃, and twice this size, which is as nearly as possible red-hot. It may be previously ascertained, if he doubts the fact, but I have often proved it, that this calcium borate ball is unchanged as to weight by re-treatment before the blowpipe, in any number of fresh beads of pure boric acid, to none of which it contributes the slightest opalescence. He now, gently and carefully, fuses or dissolves in this calcium borate, so supported, a weighed amount of the purest chemically-prepared and dried silica he can obtain, or of pure powdered rock-crystal, before the blowpipe.

(2.) When the silica is completely and transparently dissolved by O.P., the siliceous calcium borate is run off the wire while it is red-hot on to a clean tray of aluminium, by inclining the wire upwards at first, so that the ball may slide, while hot, off the hooked part on to the shank of the wire. The hooked part is then carefully straightened, when cool, with *clean* forceps, and the now straight wire, with the ball upon it, held perpendicularly downwards over the aluminium tray, when a little O.P., pointed slightly above it, soon runs the ball off the wire into the tray, and it is then carefully weighed, when quite cold, in an assay balance.

(3.) The siliciferous calcium borate is now taken upon a hot bead of pure boric acid, into which it soon sinks, and treated there with O.P., when—and this is the most curious part of the reactions—a grey opaline matter is copiously evolved from the siliceous ball into the clear bead, before long rendering the latter opaque; and this opalescent emission evidently takes place *during the formation of the inner balls.*

(4.) The opaque bead containing the siliciferous ball with its transparent inner balls is now placed, wire and all, in a platinum capsule of distilled water, and boiled, when in a few seconds the soluble opaque bead is dissolved, and the insoluble calcium borate ball containing the silicon borate balls (if such they be according to

Note IX.) extracted, and applied as before, to a fresh bead of pure boric acid under O.P.

Opalescent matter is again evolved from the siliciferous ball into the fresh bead, until it, too, is rendered opaque, and more inner balls formed; and this double phenomenon of opalescence evolved and inner-ball formation is continued in proportion to the quantity of silica originally dissolved in the calcium borate. I found in my experiments of 1880 that 5 m.grms. of silica would thus render some three or four beads of boric acid nearly opaque. The most extraordinary circumstance is that, when the siliciferous calcium borate—or, as it may now be termed, the "balls-containing-ball"—is extracted by boiling from the last bead of boric acid, and weighed, it is found, notwithstanding the loss of all this opalescent matter, to have *very much increased in weight*.

Here, then, I submit, we have a beautiful illustration of the ordinary theory of CHEMICAL EXCHANGE. "Pure" silica contains "something" in combination, of almost infinitesimal weight, but in very considerable proportion, which, under the pressure of attraction or other influence, of anhydrous calcium borate before the blowpipe, is *exchanged* by it for heavier boric acid, passed on from the outer bead through the calcium borate ball.

It may be asked by my readers: "What proof have you got that this opalescent matter is not an actual part of the silica in a soluble state?" (as I long supposed it to be), and, if so, I answer—this proof: Led by my doubts on this very point, I applied 5 m.grms. of pure silica, prepared at Görlitz, in Prussia, to a boric acid bead by itself, in the first instance, before the blowpipe, where, of course, it was utterly unattacked and unaltered in weight or condition. I then applied to this silica-containing-bead a weighed ball of anhydrous calcium borate under O.P., when grey opaline matter was immediately evolved by the silica, until the whole bead became opaque. The opaque bead was then boiled, the calcium borate ball extracted and weighed, and the residual silica (washed with boiling distilled water) dried in the platinum basin, and also weighed. This operation was repeated until the bead was no longer opalescent. The calcium borate ball was precisely the same weight as before, but the silica now only weighed 2 m.grms., and, placed under the ¼-inch objective of a microscope alongside some ordinary silica on the same slide, exhibited, apparently, quite different optical properties. This quantitative experiment was several times repeated with a like result.

I shall reserve for another paper the consideration of the questions: (*a*) What this opalescent matter derived from pure silica may be supposed or proved to be; and (*b*) What I conceive to be the *rationale* of the phenomenon.

B. *Carbon-backed Tongs for Aluminium Plate.*

There is but one advantage in the use of charcoal as a support for volatile metals before the blowpipe not possessed by aluminium plate in its present form, which defect on the part of aluminium, I propose to remedy as follows:—

Sublimates deposited on charcoal can, in some cases (as, *e.g.*, antimony), be distinguished by the fleeting but distinct coloured flame or pyrochrome which they afford in the blowpipe H.P. (or R.F.) applied to the charcoal. This is not the case when they are deposited on aluminium plate, because they cannot there be deoxidised and reduced to the metallic state in which pyrochromes are afforded, so perfectly or rapidly by the blowpipe pyrocone as they can when coating charcoal. The operator, however, can easily produce this result, in addition to the many advantages of aluminium not possessed by charcoal, by cutting or sawing a thin slice of charcoal off the parallelopipeds in which it is usually sold, and fastening this slice, with thin iron wire, broad side up, on one of the legs of the iron forceps by which aluminium plate is ordinarily held. He thus obtains a black (charcoal) surface in immediate local contradistinction to a white (aluminium) surface, both of which simultaneously receive parts of the same pyroxide or coating, and their differing reactions before the blowpipe may be thus almost simultaneously compared.

ON THE PRESENT CONDITION OF THE SODA INDUSTRY.*

By WALTER WELDON, F.R.S.,
Chevalier de la Légion d'Honneur.

(Continued from p. 69).

RETURNING to the ammonia process, when that process first began to threaten them, the makers of Leblanc soda comforted themselves by two considerations: one of which was that the ammonia process must itself tend to check its own extension, by reason of the loss of ammonia inseparable from that process so increasing the demand for ammonia as to materially raise the price of that body. They knew that the constantly increasing demand for ammonia for the purposes for which it was already employed had doubled its price within twenty years; and they thought that every further extension of the ammonia-soda process must still further increase the market-value of ammonia, until at length the ammonia process would cease to have any advantage over the Leblanc process. So far, however, from that anticipation having been realised, despite the immense extension which the ammonia-soda process has recently undergone, the price of ammonia is now beginning to fall. The delusion that it was impossible to collect the ammonia given off from coke-ovens without spoiling the coke is at last giving way before accomplished facts; ammonia is now being obtained commercially not only from coke-ovens, but also from another source, wholly unforeseen and unexpected; and the time, moreover, seems at last to have dawned when there will be collected and utilised as ammonia at least a portion of the nitrogen of nearly all the fuel burnt either for industrial or for domestic purposes.

In France, ammonia has been collected from coke-ovens for a number of years past.† It is fully ten or twelve years since M. Carvés said to French coke-manufacturers: "I wish you to try my system of making coke, but I do not ask you to risk one farthing in doing so. If you will permit me, I will build coke-ovens in your works at my own expense. I will guarantee you against all risk of the coke produced being of inferior quality; so that, if I fail, you shall be no loser. If I succeed, I will ask you for no money royalty, nor will I ask you to pay me for the coke-ovens: I will only ask that you shall give me for a short term of years one-third of those products which I shall condense, but which, at present, you do not condense." This offer was accepted by some of those to whom it was addressed, with results quite satisfactory both to them and to M. Carvés. Quite recently, coke-ovens on the Carvés system have been erected in South Durham, and about three months ago ammonia from them began to appear in the market.

This fact, however, is not nearly so important as something which has been done simultaneously in North Durham. While the Carvés system of making coke gives important results, it has the disadvantage of requiring coke-ovens of a special construction. It could thus extend only in proportion as the existing coke-ovens were

* A Paper read before the London Section of the Society of Chemical Industry, at the Chemical Society's Rooms, Burlington House, London, Monday, January 8, 1883, by the Chairman of the Section.

† Not, however, I find, to any considerable extent. The only system of collecting ammonia from coke-ovens which is in use in France is the Carvés system, and that is in use only in three works: at Tamaris, at Terre Noire, and at Bességes. The total quantity of coke produced in Carves ovens in France is 300 tons per day, and the total quantity of volatile products condensed from these ovens per day consists of six tons of tar and ammonia equal to from two to two and a half tons of ammonium sulphate. The coal used in the works in question is much less nitrogenous than ordinary English coal.

replaced by new ones; and replacement of the present ovens by Carvés ovens would naturally be a slow process. For a method of collecting ammonia and other volatile products from coke-ovens to obtain wide application rapidly, it must be a method applicable to existing coke-ovens; and a method applicable to existing coke-ovens, at a very slight expense, has been recently devised by an English inventor, Mr. John Jameson, of Newcastle-on-Tyne. His method has now been in operation for nearly six months at the works of our vice-president, Mr. Hugh Lee Pattinson, at Felling, near Gateshead: and Mr. Pattinson authorises me to state that he has "reason to be abundantly satisfied with the results." The products condensed are the products of the distillation of coal at a very low temperature. They include, per ton of Northumberland steam coal operated upon, an average of eleven gallons of oil, and ammonia equal to twelve pounds of ammonium sulphate. The oil is a crude paraffin oil, of 0·9 specific gravity, containing from 8 to 10 per cent, according to the coal employed, of solid paraffin. The yield of oil will probably not be greatly increased; but it is expected that the yield of ammonia, the appliances for collecting which at Felling have hitherto been imperfect, will be increased considerably. There is also obtained, per ton of coal treated, from 12,000 to 15,000 cubic feet of combustible gases. The coke obtained is fully equal, both in quantity and in quality, to that obtained by coking the same kind of coal in the ordinary way. The cost of applying the system to existing coke-ovens does not exceed £30 per oven. Licences for applying it to 100,000 tons of coal per annum have already been applied for, and there is every prospect that its application will extend very rapidly.

While during these last few months ammonia has thus begun to be collected from English coke-ovens, it has also begun to be collected from Scotch blast-furnaces. In Scotland, there are some 120 blast-furnaces which are worked with raw coal. Recently, a member of the firm of William Baird and Co., who happens to be also a director of a gas-work, Mr. Andrew K. M'Cosh, was struck by the idea that the methods employed for separating ammonia and tar from crude illuminating gas might be used for separating the same bodies from the gases from blast-furnaces in which raw coal is used; and although the volume of gases from such furnaces, per ton of coal employed, is about thirteen times greater than that of the gases obtained by distilling the same kind of coal in retorts,—is not less, that is to say, than 130,000 cubic feet,—this idea has been put into execution with complete success. From two of the sixteen blast-furnaces at the Gartsherrie Ironworks ammonia and tar have been regularly collected for some months past, and preparations are in progress for collecting them from the other fourteen blast-furnaces there. The quantity of ammonia at present being obtained at Gartsherrie is the quantity corresponding to about 18 cwt. of ammonium sulphate per day, being at the rate of 20 lb. of ammonium sulphate per ton of coal consumed. The other products condensed from the blast-furnace gases have more resemblance to ordinary gas tar than the corresponding products obtained from the Felling coke-ovens. They are products of the distillation of coal at a temperature intermediate between the temperature at which distillation goes on in those coke-ovens and the temperature at which it is performed in gasworks; and, though the value of the blast-furnace tar has not yet been fully ascertained, it is believed to be nearly as valuable as ordinary gas-tar, though not quite. The results thus obtained at Gartsherrie have led to endeavours at other Scotch ironworks to accomplish the same object in other ways; and experiments to this end are in progress at the Monkland ironworks, the Summerlee Ironworks, the Ardeer Ironworks, and others; so that we may fairly expect that the time is not far distant when all the ammonia and all the tar which are evolved from Scotch blast-furnaces will be collected and sent into the market.

Each of these 120 Scotch blast-furnaces consumes, on an average, 50 tons of coal per twenty-four hours. The total quantity of coal consumed in them per annum is thus $50 \times 120 \times 365 = 2,190,000$ tons. The quantity of ammonia yielded per ton of coal being, as I have said, the quantity corresponding to 20 lbs. of ammonium sulphate, there can thus be obtained per annum from these 120 blast-furnaces a quantity of ammonia corresponding to nearly 20,000 tons of ammonium sulphate, worth, at the present selling price of that commodity, not less than £400,000.

Large, however, as is this quantity, it is only one-tenth of the further quantity which can be obtained from English coke-ovens. The quantity of coal coked annually in England is not far short of 20,000,000 tons, and if Mr. Jameson's system were applied to the whole of our coke-ovens, with the result of collecting, per ton of coal treated, the same quantity of ammonia as is obtained from the Gartsherrie blast-furnaces, there would be obtained from this source per annum the quantity of ammonia corresponding to 180,000 tons of ammonium sulphate, at present worth more than three and a half millions sterling. Nor is even this all; for I shall have to speak in a moment of another possible, and I believe probable, source of ammonia, even more extensive still.

Now, of the ammonia employed by the ammonia-soda maker, he loses from one-fiftieth to one-fortieth part. As he has to employ from one and a half to one and three-quarter equivalents of ammonia for each equivalent of sodium carbonate finally obtained, we may take it that he loses about one twenty-third of an equivalent of ammonia for each equivalent of sodium carbonate manufactured. In terms of ammonium sulphate, being the terms in which the loss of ammonia in the ammonia-soda process is usually stated, this loss corresponds to about five and a half parts of ammonium sulphate per hundred parts of sodium carbonate produced. The total annual loss of ammonia in the manufacture of the 163,000 tons of ammonia-soda now being produced per annum thus corresponds to just about 9000 tons of ammonium sulphate. This is, no doubt, a large quantity of a commodity worth £20 per ton; but, in comparison with the extent of the new sources of ammonia which have just begun to be turned to account, it is utterly insignificant. It is less than one-twentieth part of the quantity capable of being yielded by blast-furnaces and coke-ovens in Great Britain alone, and is a smaller fraction still of the quantity which, I believe, can be obtained from another source which has yet to be mentioned. We may, therefore, be quite certain that the progress of the ammonia-soda process will not be hindered or limited by any difficulty as regards supply of ammonia.

The other consideration to which I referred as having given comfort to the makers of Leblanc soda, and which constituted indeed their chief ground of hope for salvation against the ammonia process, was that the world requires chlorine as well as soda, and that while the chlorine of the salt decomposed by the Leblanc process is yielded as hydrochloric acid, from which free chlorine can be obtained readily, the chlorine of the salt decomposed by the ammonia process is yielded as a somewhat dilute solution of calcium chloride. It was thought that the ammonia process would eventually even help the existing Leblanc soda-makers, by preventing the further extension of the Leblanc process, and so increasing the production of hydrochloric acid, and thereby at length increasing the value of that body. The ammonia process, no doubt, would have produced that result, and would have produced it by this time, if the supply of hydrochloric acid in this country had not been already so largely in excess of the demand for chlorine products. That demand is always becoming larger, and within the last few years the production of hydrochloric acid has appreciably diminished; but in this country the constantly-increasing stringency of legislative enactments with respect to river and air pollution has compelled so many producers of hydrochloric acid, who would have preferred to throw their acid away,

to employ it in the manufacture of chlorine, whether that manufacture were profitable or not, that the selling price of chlorine products has of late years been continually falling, until it is now at a point at which it barely pays their cost. No doubt, if all the other conditions of the problem were to remain as at present, the demand for chlorine products would in time overtake the supply of hydrochloric acid in this country, as it has long since done on the Continent, and the manufacture of chlorine in England would so again become profitable. But the other conditions of the problem are not likely to remain stationary, and both M. Solvay and myself are doing our best to change them.

M. Solvay is proposing to manufacture hydrochloric acid from the residual calcium chloride of the ammonia process. I imagine that he is urged to that course, not merely by a desire to turn that calcium chloride to account, but also by a desire to avoid making too much nuisance. For it must not be supposed that even the ammonia process, when practised on a large scale, is free from nuisance. It certainly does not send into the air any noxious vapours, but it sends into the water-courses very large quantities of calcium chloride, rarely accompanied by less, and often accompanied by much more, than an equivalent quantity of sodium chloride, and very apt to be accompanied also by both calcium carbonate and free lime. Neither calcium chloride nor sodium chloride will do much harm to a river, if sent into it in moderate quantities; but when it comes to sending into a comparatively small stream, far inland, 260 tons of calcium and sodium chlorides per twenty-four hours,—say, about ten tons per hour, night and day, all the year through: and M. Solvay must be doing something very like that at Dombasle,—the matter assumes quite another aspect. I am not myself an angler, but, if I were, I do not think that I should seek for sport immediately below Dombasle.

Be all that, however, as it may, M. Solvay is now erecting at Dombasle apparatus for an industrial trial of a process for obtaining hydrochloric acid from calcium chloride, at which he has been working for many years. The process in question consists in first concentrating by evaporation the mixed solution of calcium and sodium chlorides which is the residual product of the ammonia process; then mixing the concentrated solution with clay, making the mixture into balls and drying those balls; and then heating these balls to redness in a current of steam. This process certainly works, on condition that the temperature employed be sufficiently high, and that the quantity of steam used be largely in excess of the quantity necessary to react upon the calcium chloride. As the resulting mixture of vapour of water and vapour of hydrochloric acid would otherwise give an extremely dilute aqueous acid, M. Solvay proposes to separate from it most of its vapour of water, before condensing its hydrochloric acid, by passing the mixture of the two vapours through a very strong solution of $CaCl_2$, which he finds will absorb most of the steam from such a mixture, allowing the HCl to pass on alone, so that it can afterwards be condensed in the usual way. All this is ingenious, but it can hardly be cheap. Firstly, a solution containing only about eight per cent of calcium chloride has to be evaporated, we may say to dryness; then the mixture of $CaCl_2$ and clay has to be maintained at a red heat for a considerable time, in a current of steam; and then the solution of calcium chloride used to separate steam from the resulting mixture of steam and HCl has to be prepared for use again by having all the water which it has absorbed evaporated off from it. To English manufacturers who have more hydrochloric acid than they can use, this process of M. Solvay's will seem little less than ridiculous; but one must remember that it is intended for countries in which the demand for hydrochloric acid exceeds the supply, and in which countries, moreover, chlorine products are protected by import duties. In such countries, one can quite conceive its being commercially practicable; in which case the exportation of chlorine products from England to the Continent is doomed. I ought to add that M. Solvay expects that the silico-aluminate of calcium which remains after the chlorine of his mixture of calcium chloride and clay has been driven off by steam will be useful as a cement, and will thus help to pay the cost of his hydrochloric acid.

The exportation of chlorine products from England to the Continent is, moreover, threatened in another way. The Continental manufacturers of Leblanc soda, unlike the English manufacturers of Leblanc soda, do not produce enough hydrochloric acid to meet the demand of their respective countries for that acid itself and the products which are made from it. This is partly due to the production of ammonia soda, proportionately to the total production of soda, being so much greater in France and Germany than in this country, and partly to hydrochloric acid being required in those countries for industries which in this country do not exist. Large quantities of chlorine products consequently go to the Continent from this country; our production of hydrochloric acid being still sufficient to enable us to supply not only the total English demand for chlorine, and the total American demand for chlorine, but also an appreciable proportion of the Continental demand for chlorine, and, in addition to all that, to throw a large residue of hydrochloric acid into the North Sea. The Continental Leblanc soda-makers do not like this importation into their respective countries of chlorine products from England; but they can prevent it only in one or other of two ways: either by increasing their production of hydrochloric acid, or by becoming enabled to obtain from a given quantity of hydrochloric acid a larger proportion of free chlorine than is yielded by the process at present in use. Personally, I have for the process at present in use that respect which one always feels for the bridge which has carried one over, but I am well aware that it can by no means be regarded as final. It yields chlorine cheaply; but it yields only one-third of the total chlorine contained in the acid employed, the other two-thirds being lost as calcium chloride. English chlorine manufacturers will regard almost with horror the idea of a new chlorine process, which shall yield in the free state practically the whole of the chlorine contained in the acid employed; but on the Continent there is a demand for such a process,—a demand which will no doubt be lessened, but will by no means be destroyed, by what is being done in France by the Compagnie d'Exploitation—and I am one of those who have been called upon to endeavour to supply that demand. M. Pechiney is now preparing to make at Salindres a trial on an industrial scale of a process which, I think, will supply it; and by the end of this year he will probably have obtained decisive results.

As regards the English chlorine industry, however, I do not think that its prospects are by any means so gloomy as, from what I have said so far, might at first blush appear. But I think that its salvation will come from an unexpected quarter. I think that our English manufacturers of Leblanc soda will have to cease to devote their hydrochloric acid—when they do not throw it away— exclusively to chlorine making. They would, of course, be only too glad to do so if a means could be furnished them of turning it to account otherwise, but the difficulty hitherto has been as to how to turn it to account otherwise. I believe that that difficulty is about to disappear. I am not free to enter into that matter now, and, indeed, it is not yet ripe for discussion; but I have very great confidence that new applications of hydrochloric acid, admitting of being applied very extensively, at comparatively small expense, are among the things of the immediate future.

(To be continued.)

Studies on Argentous Oxide.—Dr. W. Pillitz.—The author shows that the preparations known under this name do not represent a definite compound, and do not contain silver in an oxidised state.—*Zeitschrift.*

NOTICES OF BOOKS.

Report on Different Systems of Sewage Disposal. By C. F. Hancock. Presented at the meeting of the Hendon Local Board held the 25th November, 1882.

The author of this report has made enquiries concerning the disposal of sewage by precipitation, by irrigation, and by the pail system. We find in the first place mention of the process of Mr. Fritz Hillé, which is said to be in successful operation at Tottenham, Edmonton, and Aldershot. At this last-mentioned place it has, as we understand, been abandoned. As regards the quality of the effluent produced no definite evidence is given. We have visited Tottenham, and found that the effluent water was being discharged into the Lea—not through an open channel, but through an open pipe which vents at some depth below the surface. It hence is immediately mixed with the river water, and it is impossible to judge of its colour, odour, &c., much less to draw a sample for analysis.

The account of the lime process calls for little comment. When used it is generally either preceded or supplemented by filtration. When the sewage is poor in organic matter, or where—as at Leeds, and we may add Bradford—it has to be discharged into a very dirty river, it may pass. It must be noted that the Mayor of Birmingham merely states that "to a certain extent it has been effective," but that it has not been a "great success." Like all the processes in which lime plays a substantive part, *i.e.*, where it does more than neutralise acids or acid salts, it fails to remove colouring matters from the water.

Goodall's process, we learn, has been abandoned at Newcastle-under-Lyme.

Irrigation is, of course, recommended by Dr. A. Carpenter, of Croydon, and Col. Jones, of Wrexham. Considering that even in France irrigation is found to chill the soil and retard the crops, we cannot, in our wetter and chillier climate, look upon its general adoption with favour.

The English Dyer. By David Smith. Manchester: Palmer and Howe. London: Simpkin, Marshall, and Co.

This work is not, as many persons seem to believe, a reprint of the "Practical Dyer's Guide," by the same author. It contains instructions for dyeing 150 shades on cotton yarns, 50 on cotton wool, 150 on worsted yarns, 100 on wool, and 50 on silk in the skein, each receipt being accompanied by a dyed pattern showing the result. There are also instructions for piece-goods, such as damasks, camlets, and lastings; for woollen shawls; for padding; for printing silk warps, skeins, and handkerchiefs; for dyeing woollen cloths, merinos, orleans, and cobourgs. This latter portion of the work is not illustrated with dyed patterns, except in the case of some receipts for fine aniline colours on cloth. On the last page are specimens of cotton yarns dyed with alizarin colours, the shades being named respectively Turkey-red, scarlet, purple, and pink. These shades, which are very fine, are not accompanied with receipts. The author remarks that "as the dyeing of these permanent colours is a speciality, special arrangements will have to be made for instructions to dye them, for I feel convinced that if I were to give a full and clear information on the making of the mordants and the manner of using them, no man without a practical knowledge of this hidden treasure could manipulate these colours." This is so far correct that we have seen dyers well conversant in producing the old wood, &c., colours, the cochineal, and the aniline shade, prove but very imperfectly successful with the alizarin, or, as they were formerly called, the madder colours.

An important feature in the book consists of receipts for thirty "one dip dyes" on cotton yarns. The necessity now felt for economising time and labour has caused a great demand for methods of dyeing which can be completed in one bath.

Almost all the appended patterns are good of their respective kinds, so that the accompanying receipts may be used with confidence. There is also much useful information on dye-wares, mordants, &c., and a glossary of terms. We may safely say that the author merits the good-will of the British dyeing trade for his diligence in furnishing them with sound practical instruction.

The Minerals of New South Wales. By Archibald Liversidge, F.R.S., A.R.S.M., Professor of Chemistry and Mineralogy in the University of Sydney, &c. Second Edition.

This contribution to the mineral wealth of New South Wales was originally read as a paper before the Royal Society of the Colony in 1874, and appeared in the *Transactions* of the Society for that year. Since that time every opportunity has been taken advantage of by the author to correct and extend it, particular attention being paid to the chemical composition of the minerals. The specimens described are mainly those which the author has collected or have come under his own personal observation.

The pamphlet is divided into two parts—metallic and non-metallic minerals. In the former, an interesting account is given of native gold found in the Colony in the form of nuggets and dust, its associations, and numberless assays of the metal from different localities, to which are added quotations from various sources regarding the long-disputed question as to the discovery of gold in the colony. This latter matter we think might have been more appropriately given as an appendix. The principal minerals containing copper and iron are pretty fully treated of, chemically and geographically, and statistics are given showing the quantity of copper produced in the Colony for the last twenty-three years.

It is interesting to note that native lead is again reported to have been found—this time by the miners in the gold-fields, in association with serpentine. One specimen examined by the author did not seem to have been reduced artificially, although he states that the majority of the specimens which have passed through his hands were derived from bullets.

The very rare mineral Greenockite is said to have been found associated with zinc blende and quartz. Antimony is represented by stibnite, cervantite, and jamesonite; no authentic record, however, has yet been made of the occurrence of the native metal.

The interesting fact is pointed out by the author that nearly all the minerals that are usually found associated with cassiterite in Cornwall, Germany, and France are met with this mineral in New South Wales, and mentions the finding of tin-stone pseudomorphous after felspar crystals similar to those from St. Agnes Mine, Cornwall. As an example of the occurrence of the cerium metals we have an analysis of a mineral containing them, which would seem to correspond with the composition of monazite.

In Part II. many of the commoner non-metallic minerals found in the colony are described, including the carbonaceous species and gems. A considerable portion of this section is taken up with valuable analyses of the coals, their calorific intensities, yield of coke, and general physical properties. The quantity of sulphur in these fuels, the author says, "is by no means excessive, and they will in this respect compare not unfavourably with those of other countries."

With the descriptions of the species are given the percentages of the constituents, which is necessary; but we think it objectionable to attach formulæ as well, especially as no table of chemical equivalents is given, or what new and mixed system the author has adopted. For instance, we have AgCl and AgS for kerargyrite and argentite, also Sb_2S_3 for stibnite, SbO_4 for cervantite, and H_2O for water.

As a descriptive mineralogical account of a vast area

this work is but a small instalment of what might be expected from a colony with such mineral wealth at its disposal: it is, however, a step taken in the right direction, and will doubtless do much good service in showing up the mineral resources of New South Wales.

Report of the Commissioner of the Imperial Mint for the Year ending the 30th of the 6th month of the 15th Year of Meiji (30th June, 1882). Hiogo.

The vast strides which the Japanese are making towards "Civilisation" is amply shown by such reports as the one now before us. As a criterion of their enterprising spirit we think hardly anything better could be obtained than the statistics of their coinage as is here offered for examination. During the past year the amount of gold bullion imported into the Imperial Mint exceeded thirty-eight thousand troy ounces, the silver bullion almost three-and-a-half million ounces, and of copper about one-and-a-million pounds. The grand total value of coins struck during the year equalled five-and-a-quarter million yen. The gold and silver passed through the refinery exceeded fifty-five thousand ounces of the former metal and six-hundred and-seventy thousand ounces of the latter.

Under the able supervision of Mr. W. Gowland' A.R S.M., important improvements have been introduced into the metallurgical processes connected with the coinage and the working up of old bronze guns for copper money. In the refining process an experimental trial has been made of Gutskow's method of parting, in which ferrous sulphate is used for precipitating the silver, instead of copper, with such satisfactory results that in future the process is to be adopted whenever the cupric sulphate produced as a by-product in the latter process cannot be disposed of to advantage.

The standard of the coinage, as checked by the English and United States Mint Assayers, is maintained with wonderful exactness.

Although the Japanese are credited with being an ingenious and crafty race, we note with interest that only six counterfeit coins are reported during the year, from various localities.

CORRESPONDENCE.

ESTIMATION OF CHLORINE IN BLEACHING-POWDER.

To the Editor of the Chemical News.

Sir,—The method of estimating the available chlorine in bleaching-powder, given by Mr. J. W. Chalmers Harvey, would be far too tedious for ordinary use. It is more easily estimated by Penot's method, given by Fresenius, viz., by a standard solution of sodium arsenite, the end of the reaction being denoted by potassium iodide and starch paper. Having a number of bleaching-powder samples to do in a day, I should find it a very lengthy task by Mr. Harvey's method, using three solutions, one of which is not reliable on account of its quick oxidation.—I am, &c.,

G. H.

Manchester.

Determination of Tannin in Tanning Materials, Liquids, and Waste-Products.—A. Gawalovski.—The methods of Hammer, Müller, Fehling, Handtke, Löwenthal, Wildenstein, Risler-Beunat, &c., are all defective. The volumetric methods are all the more uncertain the larger the proportion of precipitable matter other than tannin. The author prefers Hager's method,—precipitation as copper tannate. He collects, dries, weighs; then ignites, and deducts the weight of the residual copper oxide from the weight of the copper tannate.—*Zeitschrift.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 4, 1882.

Tables for the Rapid Determination of the Alcohol in Spirituous Liquors by the Distillation Method.—Dr. G. Dahm.—These tables are founded upon those of Hehner.

Causes of the Chlorine Present in Oxygen Gas prepared from Potassium Chlorate.—A. Wagner.—Commercial potassium chlorate yields under all circumstances oxygen gas containing chlorine. Chemically pure chlorate yields oxygen free from chlorine if the action of carbonic acid or of organic matter is excluded. Carbonic acid, with the aid of heat, decomposes pure potassium chlorate in such a manner that chlorine is liberated. Organic substances act in a similar manner, and the residue has a strongly alkaline reaction. The presence of calcium chlorate also occasions the liberation of chlorine. The manganese ore used for the preparation of oxygen gas along with potassium chlorate, not unfreqently contains an appreciable quantity of organic matter.

Determination of Titanic Acid in Presence of Iron.—E. Wigand.—The author criticises the method of Pisani (see *Comptes Rendus*, lix, p. 289, 1864, and *Zeit. Anal. Chemie*, iv., p. 419, 1865), and shows that it is untrustworthy.

The Qualitative Detection and the Quantitative Determination of Arsenic, Sulphur. Phosphorus, and Foreign Metals occurring in Small Quantities in the Copper of Commerce.—Dr. J. Loewe.—Reserved for insertion at length.

The Volumetric Determination of Phosphoric Acid.—Drs. Kratschmer and Sztankovansky.—The authors have examined Perrot's volumetric process for the determination of calcium and magnesium phosphates by means of a solution of silver nitrate. They confirm and correct the statements of Perrot. The yellow precipitate formed by the alkaline salts of ortho-phosphoric acid with silver nitrate is tribasic silver ortho-phosphate, insoluble in water, but soluble in nitric acid and ammonia. A complete separation of phosphoric acid from alkalies and alkaline earths by means of silver is practicable. The authors pour into a measuring flask the accurately-measured quantities of the solution of the phosphate and of silver nitrate (1 c.c.=0·001 grm. phosphoric acid), the latter being of course in excess, apply heat, add, if necessary, dilute ammonia from a burette till perfect neutrality is reached, boil up, let settle, and grow cold. If the clear supernatant liquid is found to be neutral, and if a drop of dilute ammonia does not occasion a trace of turbidity, the flask is filled up to the mark with water, closed with a caoutchouc stopper, and the contents well mixed by inversion, and filtered. Aliquot parts of the filtrate are now taken, and the excess of silver determined in them by back-titration according to known methods. The authors consider the method accurate, easy, and expeditious.

Detection of Benzoic and Boric Acids in Milk.—Dr. E. Meissl.—For benzoic acid 250 to 500 c.c. of milk are rendered alkaline by means of a few drops of lime or baryta water, evaporated down to one-fourth, stirred up to a paste with gypsum, and dried on the water-bath. Sand or pumice may be used instead of gypsum. The dry mass is finely powdered, moistened with dilute sulphuric acid, and three or four times shaken up with double its volume of cold alcohol at 50 per cent. The alcoholic extracts, which, in addition to benzoic acid, contain lactose and inorganic salts, are united, neutralised with

baryta water, and concentrated to a small bulk. This residue is again acidulated with dilute sulphuric acid, and finally shaken up with small quantities of ether. The ethereal extract on evaporation leaves benzoic acid in a state of almost absolute purity. For the quantitative determination this residue is dried in the desiccator, weighed, the benzoic acid is expelled by sublimation, and the residue is weighed again, the loss being benzoic acid. Sublimation is best effected in the water-bath, the capsule being covered with a watch-glass. As soon as the benzoic acid begins to sublime, the space beneath this glass appears full of minute spangles of benzoic acid, and is very characteristic. As soon as the larger portion of the benzoic acid is deposited in the covering glass it is removed, and the contents used for qualitative reactions. The lower capsule is heated uncovered till all the benzoic acid has escaped. The test with neutral ferric chloride succeeds best with the benzoic acid dissolved in water and mixed with a drop of sodium acetate. Boric acid is not capable of quantitative determination, except present in such quantities that its weight may be deduced from the increased percentage of the ash. The flame-reaction is untrustworthy, as the ash of pure milk gives a flame bordered with green. The following method is recommended: 100 c.c. milk are rendered alkaline with lime water, evaporated down, and incinerated. The ash is dissolved in a minimum of strong hydrochloric acid, filtered from the carbon, and evaporated to dryness. The residue is moistened with a little dilute hydrochloric acid, the crystalline paste is moistened with tincture of turmeric, and dried on the water-bath. In presence of the smallest trace of boric acid the dried residue is of a distinct vermilion, or cherry red. In this manner 0·001 to 0·002 per cent in the milk can be distinctly recognised. Strong hydrochloric acid gives also a cherry red colour with turmeric, which, however, disappears on the addition of water, and on drying turns brown. The boric colour only appears on drying, and is not removed by water except boiling or in excess.

Method for Determining the Fixed Organic Acids in Wine, and a New and Accurate Method for Determining free Tartaric Acid.—C. Schmitt and C. Hiepe.—The acids in question are the tartaric, the malic, and the succinic. The first-mentioned must be removed before the two others can be determined. The authors pronounce the method of Kayser (*Repertorium Anal. Chemie*, i., p. 20) inapplicable. The principles of their method are:—(1.) Separation of the entire tartaric acid from the concentrated neutralised wine as a calcium salt and calculation of its quantity from the normal hydrochloric acid required for neutralising the caustic lime obtained on igniting the calcium tartrate, with a correction for the tartaric acid remaining in the filtrate. (2.) Precipitation of the mixed calcium salts of malic and succinic acids by the addition of alcohol. (3.) Conversion of these weighed calcium salts into neutral alkaline salts, precipitation of the succinic acid, calculation as a calcium salt, and calculation of the malic acid from the difference in weight of the total calcium salts and the calcium succinate. For precipitating the succinic acid a property is utilised which is not yet known. Neutral alkaline succinates are at once and completely decomposed by barium chloride at a boiling heat. The deposit of barium succinate is dissolved with hydrochloric acid. From this solution the baryta is thrown down with sulphuric acid, and 1 mol. barium sulphate in the precipitate represents 1 mol. succinic acid.

Absorption Apparatus for Elementary Analysis.—Clemens Winkler.—The author figures and describes a new and apparently advantageous apparatus for the absorption of carbonic acid, watery vapour, &c.

Detection of Organic Acids in Phenol.—W. Bachmeyer.—Whilst a single drop of the ordinary inorganic acids in a concentrated state decolourises the aqueous extract of sapan wood, &c., but a further addition brings out the red colour again, the organic acids, with the exception of phenol, behave differently, since an excess does not reproduce the colour. The author has examined in this respect the acetic, oxalic, malic, tartaric, citric, succinic, uric, benzoic, hippuric, salicylic, and tannic, and found that all produce the permanent discharge of the colouring-matter. An aqueous extract of any of the red woods is therefore well suited for detecting any organic matter present in phenol, and especially for distinguishing phenol from salicylic acid in the absence of other acids.

Detection of Soda in Milk.—W. Bachmeyer.—The milk to be examined must have an alkaline reaction, which will always be the case in recent milk sophisticated with soda. The cream is removed and portions of 15 c.c. are placed in flat capsules. To the first are added 3 c.c., to the second 5 c.c., and to the third 10 c.c. of a moderately strong solution of tannin, and the samples are then allowed to stand eight to twelve hours in a cool place. The author's experiments show that a proportion of soda of 0·3 grm. per litre betrays itself by a deep, dirty greenish blue colour; samples free from soda, after standing from twelve to twenty hours, show at most a dull grey. The test is confirmed by the addition of a few drops of dilute acetic acid, which produce in the greenish samples a transitory green colouration.

Determination of Phosphoric Acid and Magnesia.—Dr. K. Broockmann.—The usual method of determining ammonium magnesium phosphate as magnesium pyrophosphate by ignition involves certain sources of error which cannot be avoided, even with the utmost care. Such are the double salts creeping up the sides of the beaker and of the funnel, so that it is not readily brought into the filter without loss; then there is loss in the form of dust on introduction into the crucible, and thirdly there are variations in the ash of the filter. To avoid these sources of error the author dissolves the washed precipitate direct from the filter, and any particles present in the beaker in nitric acid, places the solution in a weighed crucible, evaporates to dryness, and ignites.

Colorimetric Determination of Small Quantities of Phosphoric Acid.—J. West-Knights.—From the *Analyst*.

Behaviour of Nitric Oxide with Potassium Permanganate.—A. Cavazzi.—Nitric oxide is converted into nitric acid by solution of permanganate. The author recommends a hot concentrated solution of permanganate as an excellent absorbent for nitric oxide in gas analysis.

MEETINGS FOR THE WEEK.

MONDAY, Feb. 19.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field.
TUESDAY, 20th.—Royal Institution, 3. "The Supreme Discoveries in Astronomy (The Scale on which the Universe is Built)," by Professor R. S. Ball.
—— Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 21st.—Society of Arts, 8. "Recent Improvements in Agricultural Machinery," by D. Pidgeon.
—— Meteorological, 7.
—— Geological, 8.
THURSDAY, 22nd.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
—— London Institution, 7.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "Some Causes of Fires and Methods for their Prevention," by Walter G. McMillan, F.C.S.
FRIDAY, 23rd.—Royal Institution, 8. "Sir Francis Drake," by Mr. W. H. Pollock, at 9.
—— Quekett Club, 8.
SATURDAY, 24th.—Royal Institution, 3. "Singing, Speaking, Stammering," by Dr. W. H. Stone.
—— Physical, 3. "Optical Combinations of Crystalline Films," by Lewis Wright. "Experimental Demonstration of the Vorticle Theory of the Formation of a Solar System," by Philip Braham.

THE CHEMICAL NEWS.

Vol. XLVII. No. 1213.

ON THE EXAMINATION OF AMERICAN CHEESES.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts, Medallist in Chemistry and Botany, &c.

The author has recently submitted to careful analysis four samples of American cheese purchased in London, and handed to him for analysis. The results are as follows:—

	I.	II.	III.	IV.
Water.. ..	23·49	28·20	26·55	31·81
Caseine ..	36·21	37·01	35·58	36·10
Fat	34·92	30·18	33·85	28·68
Ash	5·24	4·51	3·90	3·40
	99·86	99·90	99·88	99·99

The author also made a separate analysis of the rind in each case, and in samples Nos. I. and IV. a small amount of arsenic was found. This was probably applied to the external surfaces of the cheeses to prevent the attacks of insects, &c.,—a practice which is dangerous to the consumer, and ought to be prohibited by law. I also examined microscopically each of the samples of cheese for vegetable fibres, &c., and starch granules, but found no traces.

London, January 31st, 1883.

SUPERSATURATION.

By SPENCER UMFREVILLE PICKERING, B.A. (Oxon.)

Supersaturation is not, I believe, generally supposed to take place in a solution when any of the solid substance is present: I had occasion, however, to notice an instance in which it took place under these circumstances to a marked extent.

A boiling saturated solution of copper sulphate had been left to filter undisturbed into an open beaker. When almost cold a considerable crop of crystals had formed on the bottom and sides of the beaker and on a glass rod in it; but on moving this rod a sudden deposition of very small crystals of the sulphate took place, amounting to about twice the quantity of those which had separated slowly, and which could not have weighed less than 100 grammes.

NEW AND MODIFIED SPECIFIC GRAVITY APPARATUS.

By W. W. NICOL.

In the Chemical Society's *Journal* for 1873, p. 577, occurs a description of the now well-known Sprengel tubes for the determination of the specific gravity of liquids. The form there described has, however, certain disadvantages: it is by no means easy for an inexperienced glass-blower to make such a tube, and when made it is difficult to fill without including air bubbles, or entailing some loss of liquid. After I had used the above form for some time, I modified it as follows, and have used this modified form in many hundred experiments without observing that it is in any way inferior in accuracy to the original form described by Sprengel.

The accompanying figure (1) gives the form of the tube. It is made from a test-tube 15 m.m. in diameter, the length of the wide part is 115 m.m., and the distance from the shoulder to the bend is 40 m.m. to allow of the total immersion of the body of the tube in the water of the constant temperature bath. The capillary tubes have

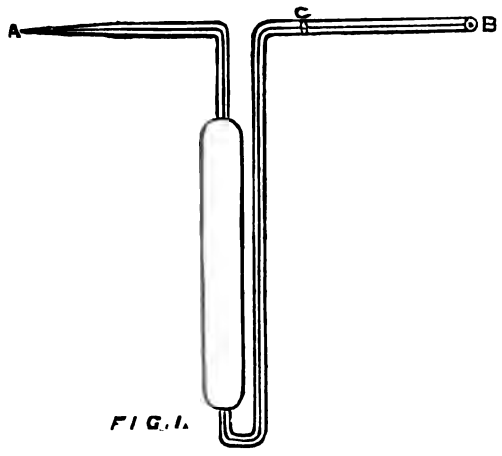

FIG. 1.

an external diameter of about 2·5 m.m., and a bore of 0·5 to 0·7 m.m. The total length from A to B is 180 m.m., and the mark is at C. Such a tube weighs 15 to 16 grms., and holds 13 to 15 c.c., and is capable of giving results with a maximum error of $\pm 0{\cdot}00002$.

The above form of tube can of course only be used to determine the specific gravity of liquids, but the following modification adapts it for the determination of that of solids soluble in water (Figure 2):—The only differences

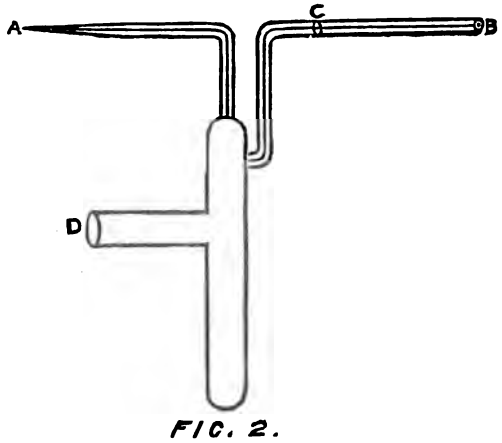

FIG. 2.

from the foregoing are that the wide capillary starts from the upper part of the body of the tube, and that half way down a wide open tube is joined in at right angles. The use of this apparatus is as follows: The salt (in fine powder) whose specific gravity is to be determined, is shaken in by D. The outer edge of D is then softened in the blowpipe flame, closed, and rounded by gently blowing in at B. The whole is then weighed, partially filled with paraffin oil, the air exhausted by B until on shaking up the powdered salt no air bubbles make their appearance, then filled up with paraffin, and, after attaining the temperature of the bath, again weighed. Then washed out with water and alcohol, dried, and weighed—first empty, then

full of boiled water, and finally full of paraffin oil. These five weighings give all the data necessary for the calculation. To use the tube again all that is necessary is to soften the end of D in the flame and to blow it open. The time required for a determination with this apparatus is rather more than that when using the bottle, but the accuracy exceeds greatly that obtainable by the ordinary method.

The Mason Science College, Birmingham,
February 3, 1883.

NEW PROCESS FOR THE RAPID VOLUMETRIC ESTIMATION OF CHROMIC ACID IN CHROMATES AND BICHROMATES.

By J. W. CHALMERS HARVEY.

THE *modus operandi* of this method is the same as in the one I proposed for the rapid estimation of peroxide of manganese in commercial binoxide (CHEMICAL NEWS, vol. xlvii., p. 2).

The principle of it consists in heating the sample to be analysed with excess of stannous chloride and hydrochloric acid, the reactions taking place being :—

(1) $K_2Cr_2O_7 + 14HCl = 2KCl + Cr_2Cl_6 + 7H_2O + 3Cl_2$.
(2) $3SnCl_2 + 3Cl_2 = 3SnCl_4$.

The excess of stannous chloride is determined by mixing the solution with an excess of ferric chloride and estimating the equivalent quantity of ferrous chloride which it forms by a standard solution of potassic bichromate. The reaction in this case is—

(3) $3SnCl_2 + 3Fe_2Cl_6 = 6FeCl_2 + 3SnCl_4$.

From these equations it is seen that two molecules (200·4 parts) chromic acid oxidise the same quantity (viz., three molecules) of stannous chloride as three molecules ferric chloride containing 336 parts iron.

Now, if we take two equal measured quantities of a strong solution of stannous chloride, mix one directly with excess of ferric chloride, heat for a short time, and estimate the iron converted into the ferrous condition by the standard bichromate of potash, then add to the other measured quantity the chromate to be analysed, some hydrochloric acid, and heat until complete decomposition is effected, treat this also with an excess of ferric chloride, and lastly estimate the iron converted into ferrous chloride : we get a difference which is due to the oxidising function of the chlorine evolved by the action of the hydrochloric on the chromic acid. Now as we know that 336 parts iron as ferric chloride are equal to 200·4 parts chromic acid in oxidising power, it is easy to find the percentage of this latter. Suppose 1 grm. substance has been taken, and that the difference when multiplied up to the percentage = 67 parts iron, then—

Fe	CrO_3	Fe
336 :	200·4 : :	67 = x = 40 per cent CrO_3.

The requisites for this process are as follows :—

Standard Solution of Potassic Bichromate.—Dissolve 15 grms. of the pure salt in hot water, and when cool make up to 1 litre. 1 c.c. = 0·017 grm. iron = 0·01014 grm. chromic acid.

Solution of Stannous Chloride.—This should contain stannous chloride in the proportion of 330 grms. to 1 litre. It is made by heating the salt with hydrochloric acid until a clear solution is obtained, and then diluting up to 1 litre if the above quantity has been weighed out.

Solution of Ferric Chloride.—Prepared by dissolving pure iron wire, or almost pure peroxide of iron, if obtainable (say pencil hematite), the former in hydrochloric acid, oxidising with potassic chlorate, and evaporating off excess of chlorine, the latter in hydrochloric acid. This solution must be absolutely free from ferrous chloride and chlorine. I used ferric chloride made from hematite iron ore containing 64 per cent metallic iron. The ore when dissolved was found to contain a trace of ferrous chloride, which was oxidised by heating with a little potassic chlorate. 50 grms. of this ore were dissolved = 32 grms. iron, and made up to 1 litre. The iron solution need not of course be of this particular strength ; it may vary, but should not be too dilute.

Conduct of Process.—Suppose the substance in which the chromic acid is to be estimated be potassic bichromate. Weigh out 1 grm., place in a beaker, add 10 c.c. of the stannous chloride, then some hydrochloric acid, cover the beaker with a watch glass, and heat until complete solution is effected ; now mix with excess of ferric chloride (an excess may be ascertained by testing a drop of the solution with potassic sulphocyanide), heat again for a minute or two to promote the action of the stannous chloride on the ferric chloride, and lastly titrate with the standard bichromate until a drop of the solution when tested just fails to give a bluish green colouration with potassic ferricyanide. Note the number of c.c. used to effect this result. Now mix 10 c.c. of the stannous chloride directly with an excess of ferric chloride, heat for a short time, and titrate with the bichromate as indicated above until all the iron is oxidised to ferric chloride. Note the number of c.c. used. The difference between the number of c.c. used in the two experiments when multiplied on 0·017 gives a quantity of iron which would have been deoxidised if the stannous chloride had not been previously heated with the chromate ; this, therefore, is equivalent to the chromic acid contained in the chromate, and as the quantitative relation between these two substances is known, the amount of chromic acid is easily calculated.

But it is much easier to multiply the difference between the number of c.c. by 0·01014, which is the CrO_3 = to 0·017 grm. iron ; this being the value of each c.c., the number obtained when multiplied by 100 gives the percentage.

Experiments to Test the Accuracy of the Process.—Four experiments conducted in this manner with potassic bichromate gave :—

	Theory.	Above Process.
Chromic acid ..	67·88	67·72 per cent
,, ..	—	67·73 ,,
,, ..	—	67·93 ,,
,, ..	—	67·93 ,,
Mean		67·83 ,,

Plumbic chromate was prepared by dissolving plumbic acetate in water, heating, and precipitating with potassic bichromate. The precipitate was collected on a filter, washed thoroughly with hot distilled water, and dried for a considerable time at 212° F.

Three experiments conducted as described gave :—

	Theory.	Above Process.
Chromic acid ..	31·08	31·18 per cent
,, ..	—	31·28 ,,
,, ..	—	31·28 ,,
Mean		31·24 ,,

In estimating the chromic acid by this method in the above salt some $PbCl_2$ precipitates, but this does not interfere with the estimation.

Baric Chromate.—This was prepared by precipitating barium chloride with potassic bichromate, collecting the precipitate on a filter, washing thoroughly with hot distilled water, and drying for a long period at 212° F.

Three experiments gave :—

	Theory.	Above Process.
Chromic acid ..	39·65	39·85 per cent
,, ..	—	39·64 ,,
,, ..	—	39·54 ,,
Mean		39·67 ,,

With the plumbic and baric chromates, 5 c.c. of the stannous chloride are sufficient for 1 grm. substance used.

The strength of the stannous chloride should always be determined before each series of experiments, its liability to change being well known. Although the above process may seem rather complicated, in reality it is not so, and on the score of expedition it certainly lacks nothing, an estimation being performed in ten minutes or so. In regard to accuracy it will be observed that the results are pretty nearly in accordance with theory.

My best thanks are due to my assistant, Mr. Hugh Davidson, who assisted me with the necessary experiments.

Chemical Laboratory,
Maryport Iron Works, Maryport,
February 3, 1883.

THE ACTION OF POTASH UPON ALBUMEN.

By G. STILLINGFLEET JOHNSON.

I HAVE recently been investigating very carefully the changes undergone by the *sulphur* of albumen when that substance is boiled with solutions of potash of various strengths, and, as the results are interesting and, to some extent, unexpected, I am anxious to lay them before scientific chemists, that they may be put to the test of experiment.

The general consensus of opinion of chemists upon this subject is thus epitomised: "Dilute solutions of potash and soda mix with albumen in all proportions, and on boiling the liquid an alkaline sulphide is formed." (*Vide* "Watts's Dictionary of Chemistry," vol. i., p. 67.) Now this statement I believe to be erroneous, and my belief is based upon the following experimental evidence:—

If white of egg or pure albumen be boiled with dilute solution of potash in presence of lead, *e.g.*, in a solution of lead hydrate in excess of potash, an abundant production of *lead sulphide* is observed. But if white of egg or pure albumen be boiled with dilute potash alone (sp. gr. 1·08), the sulphur of the albumen is not converted into sulphide of potassium, but gradually enters into combination with oxygen and potassium, to form a salt of potash with an oxidised sulphur acid; the proof of this being that if the liquid be cooled at intervals of ten minutes, and solution of lead be added to the cold alkaline solution, no lead sulphide is produced, and after the boiling has been prolonged for a certain time, no sulphide is formed even on boiling in presence of lead.

Now, in performing these experiments, it is necessary to bear in mind that white of egg is not pure albumen. When fresh white of egg is boiled with dilute potash for a short time, the liquid cooled, and some solution of lead acetate added, a deep red colour is produced, which might easily be mistaken for an indication of sulphide. But if a solution of white of egg be filtered through charcoal, and subsequently boiled with dilute potash, and then tested with lead, no red colour is produced. If the white of egg solution decolourised by charcoal be boiled with solution of lead hydrate in dilute potash, lead sulphide is at once formed, thus proving that the sulphur of the albumen is not removed by the charcoal. Again, if pure albumen, prepared by the method of Wurtz, be tested by boiling with weak potash alone, and with the same potash in presence of lead, no indication of the formation of sulphide is obtained, either as colouration or precipitate, in the alkaline albuminous liquid containing no lead, whilst that which was boiled in presence of lead is full of precipitated lead sulphide.

Those who have repeated my experiment of subjecting albumen to the prolonged action of boiling dilute solutions of potash have concurred with me as to the fact that, after sufficiently prolonged boiling, no indication of sulphide can be obtained in the boiled liquid. A theory has been proposed to account for this fact, retaining the hypothesis that an alkaline sulphide is produced, viz., that sulphide of potassium is first formed, and undergoes gradual oxidation by the oxygen of the air during the boiling. My objection to this theory is based upon the results of two experiments: First—If the ebullition of the albumen and dilute potash be conducted in an atmosphere of carefully-purified hydrogen gas, the result is the same as when it is conducted in presence of air, *i.e.*, after a sufficiently-prolonged ebullition, no sulphide can be detected in the boiled liquid, even on boiling in presence of lead. Secondly—If the alkaline albuminous solution, which has been boiled in presence of air till no indication of sulphide can be observed, be mixed with some concentrated solution of potash (sp. gr. 1·3) and again boiled, an abundant production of sulphide occurs. Now, neither sulphate of potash nor hyposulphite of potassium undergoes reduction to sulphide when boiled with concentrated potash and solution of albumen which has been deprived of its sulphur by ebullition with strong potash and lead and filtration from the lead sulphide. But the whole of the observed phenomena are accounted for upon the hypothesis that the sulphur of the albumen is converted by ebullition with dilute potash into *tetrathionate*.

Tetrathionate of potash is stable, or, at least, yields no sulphide, when boiled with dilute solutions of potash, but it produces sulphide of potassium in abundance on boiling with concentrated potash. Of course it follows from this that alkaline sulphide will be produced when albumen is boiled with concentrated potash from the first, as has actually been observed. Nevertheless, I think I am justified in asserting that the sulphur of albumen is converted, *not* into sulphide, but into tetrathionate, when the albumen is boiled with potash, and that the formation of sulphide of potassium when strong potash is employed is simply due to the instability of tetrathionate of potash in boiling solutions of that reagent.

King's College, February 15, 1883.

ON THE PRESENT CONDITION OF THE SODA INDUSTRY.*

By WALTER WELDON, F.R.S.,
Chevalier de la Légion d'Honneur.

(Concluded from p. 81).

As regards soda, the position of the English Leblanc soda-makers is this. They are now working, when not actually at a loss, at least without profit. Until comparatively recently, they supplied the whole of the English demand for soda, the whole of the American demand for soda, and a large part of the Continental demand for soda. Both their home market, however, and their American market have been recently invaded by English-made ammonia soda, and now the manufacture of ammonia soda has begun in the United States themselves, and will have reached there, before the expiration of this year, a scale of 20,000 tons per annum, while a little later on that Belgian soda and copper work of which I spoke will not only have put an end to all export of English soda to Belgium, but will, doubtless, also be sending Leblanc soda to America; as will also, no doubt, the great work which is being built at Marseilles, and, eventually, those other works which are about to be built at others of the French sea-ports. The exportation of English soda to Austria, which has already dwindled to little more than 8000 tons per annum, is expected to cease entirely before the end of the present year, by reason of the increased quantity of ammonia soda which will soon be made in Austria. An increased production of ammonia soda is similarly expected to put an end, almost immediately, to the importation of English soda into Germany, which importation in 1881 was already only two-thirds of what it was in 1879. Russia, moreover, will soon be making for herself at least a portion of the soda she consumes; and France, which country has hitherto been entirely dependent upon

England for her supplies of caustic soda, though she has long ceased to take from us any other form of soda, will soon be making herself all the caustic soda she requires; for, apart from what may be done by the new company of which I have spoken, M. Solvay is just beginning to make caustic soda at Dombasle, and contemplates making it there on a very extensive scale.

In face of all this, how are the English Leblanc soda-makers to continue to live? For one thing, it is quite certain that they must have cheaper pyrites. The present price of 6d. per unit is an artificial price, entirely due to a trade combination; and that price will certainly have to be reduced by at least 50 per cent. That it can be reduced to 3d. per unit, and yet leave a very fair profit to the pyrites sellers, I believe there can be no doubt. At the present price of copper, and at 3d. per unit for sulphur, pyrites showing 2½ per cent of copper by Swansea assay would sell for thirty-nine shillings per ton; and that Spanish pyrites can be delivered to English ports at that price at a fair profit is, I believe, unquestionable. If, therefore, the existing companies refuse to supply pyrites at that price they will simply call into existence other companies which will supply it at that price. That the Leblanc soda-makers will thus get their sulphur at a price not exceeding 3d. per unit, after the end of next year, when the present combination between the pyrites companies will expire, may be regarded as quite certain.

Pyrites at 3d. per unit, however, would by no means bring down the cost of Leblanc soda to that of ammonia soda. Without using any figures which have been given to me privately, there is no difficulty in arriving, very approximately, at the difference between the cost of ammonia soda and that of Leblanc soda, from what is matter of public knowledge with respect to the dividends paid by joint-stock companies which make ammonia soda and publish balance-sheets. We learn in this way that, when Leblanc soda is yielding no profit at all, ammonia soda is yielding fully £1 per ton. As to make a ton of actual sodium carbonate by the Leblanc process does not require more than about 13·5 cwts. of pyrites, reduction of the price of pyrites to 3d. per unit would thus reduce the cost of Leblanc soda only by about 7s. 9d. per ton of actual sodium carbonate.

Seven shillings and ninepence, however, is something; and, as regards the balance of the pound, there are two resources, which together will, I think, be sufficient to turn the tables upon the ammonia process, and make the good old Leblanc process the cheaper of the two.

One of these two resources consists, of course, in sulphur recovery. If sulphur recovery were the only resource,—which, however, happily it is not—I think it not impossible that the required twelve shillings and threepence per ton of sodium carbonate could be gained by it alone. To this end, except in localities in which there is a demand for sulphuric acid free from arsenic, the sulphur must be recovered, not as sulphuric acid for use again, but as free sulphur, for sale as such. At the general meeting of our Society at Manchester, last July, I explained that, while the Schaffner and Helbig process would yield as sulphuric acid practically the whole of the sulphur of the calcium sulphide contained in the waste treated by it, it would probably yield as free sulphur only four-fifths of the total sulphur contained in the waste as calcium sulphide. Since then reason has arisen for a very confident hope that the whole of the sulphur of the calcium sulphide contained in the waste may be obtained in the free state; in which case the yield will be almost exactly 6 cwts. of free sulphur per ton of actual sodium carbonate manufactured. If, therefore, one were dependent for that twelve shillings and sixpence on sulphur recovery alone the problem would be narrowed to this:—Can free sulphur be obtained from alkali-waste at such a cost, and is there a sufficient demand for free sulphur at such a price, that it shall be possible to sell recovered sulphur, in sufficient quantity, at two shillings and a halfpenny per cwt., or say forty-one shillings per ton, more than the cost of producing it?

As regards the demand for free sulphur, the latest returns published by the Italian Government show that the average annual production of sulphur in Sicily and Italy, during the five years 1875 to 1879 inclusive, was 282,000 tons, of which 216,000 tons were exported. The total quantity of sulphur that could be produced from English alkali-waste does not exceed two-thirds of this latter quantity. The world thus consumes much more sulphur than the English alkali makers could produce, and although to sell all that they could produce they must drive much of the Sicilian sulphur out of the market, in the present "struggle for existence" somebody must go down, and English Leblanc soda-makers may be pardoned for preferring that it should be producers of Sicilian sulphur who have to do so rather than themselves.

The actual cost of Sicilian sulphur, delivered at Marseilles,—transported in the cheapest way, in bulk, at the purchasers' risk—is about £5 per ton. To become masters of the sulphur market, and at the same time to gain by recovered sulphur the required 2s. per cwt., English soda-makers must thus be able to recover sulphur at a cost not exceeding, say, about £2 per ton. They will hardly be able to do that at first, but I think that eventually they will be able to do it. If so, and if chlorine products should again command, as I think they will again command, a reasonable price,—for a price which scarcely pays their cost is, of course, not a reasonable price—the Leblanc process will at least be able to hold its own, even without that other resource to which I have referred, and which I will now proceed to indicate.

There has come to me from Newcastle a very bold but, I venture to think, quite practical suggestion, the result of which can hardly fail to be of enormous importance, not only to the soda industry, but to almost all industries whatever. That suggestion is that the soda-maker should entirely cease to use raw coal as fuel, but should convert all his coal into coke, collecting for sale the oil and ammonia evolved during its conversion into coke, and himself using for heating purposes the gases evolved during the coking operation and the coke itself. It is believed that, in the Newcastle district at any rate, by this mode of proceeding the soda-maker would obtain his fuel virtually for nothing. In that district there is produced per annum some two millions of tons of very small coal or "duff," which is almost a waste-product, and which, singularly enough, yields more oil than the more costly kinds of Newcastle coal, while at the same time yielding a very fair coke, sufficiently good, at any rate, for use in the furnaces of chemical works, especially when its combustion is assisted by that of the gases from the ovens in which the coke is produced; and the value of the oil and ammonia obtained when this "duff" is coked in ovens to which the Jameson system is applied is greater than the cost of the "duff" *plus* the cost of coking it. And it is probable that improved condensing arrangements will render the yield, if not of oil, at any rate of ammonia, so much greater than the yield hitherto actually realised as to enable the same result to be obtained in the case of ordinary steam coal, not only in the Newcastle district, but in the Lancashire district also. If so, the cost of producing Leblanc soda in both districts will be diminished by almost the total amount of the present cost of Leblanc soda for fuel. I say "almost," because, so far as one can see, the use of raw coal for "mixing" in the black-ash process must still be continued.

And it seems to me that this idea cannot but be as applicable to almost all other industries as to the soda industry; while the result to the material well-being of mankind of its general application it is utterly beyond the power of any imagination adequately to conceive. This idea means, among other things, cheaper fuel for all purposes, an enormously increased supply of agricultural produce, and the entire suppression of smoke even in the busiest centres of industry. It means that manufacturing towns, by and bye, shall no longer deserve such names as that which Mr. Matthew Arnold recently applied to St.

Helens, and may even become tolerable in the sight of Mr. Ruskin.

And for my own part I venture to think that the same idea might be applied even to the fuel required for domestic purposes, rendering London absolutely free from smoke, and pea-soup fogs things only of tradition. I think that the time will come when our gas-works will be replaced, at least to a large extent, by establishments in which coal will be treated for the production of coke, illuminating oils, ammonia, and heating gases: the coke to be burnt in our domestic fire-places, the oils to be used for lighting the interiors of our houses, the ammonia to be employed in agriculture, to cheapen and render more abundant our supplies of food, and the gases to be burnt for raising steam for driving dynamos for lighting our streets by the electric arc.

Coming back to soda: if the suggestion in question will enable makers of Leblanc soda in certain districts to obtain their fuel for nothing, it will, of course, enable makers of ammonia soda, in similar districts, to do the same. How, then, will it help the Leblanc soda-makers? While the quantity of fuel consumed in the ammonia process is only 150 per cent on the soda produced, the quantity consumed in the Leblanc process is about 350 per cent on the soda produced. This lower consumption of coal in the ammonia process than in the Leblanc process has hitherto been one of the chief advantages of the ammonia process; but fuel for nothing will so far convert this advantage into a disadvantage, that it will reduce the cost of ammonia soda per ton only by the cost of one-and-a-half tons of fuel, while it will reduce the cost of Leblanc soda, per ton, by the cost of fully twice that quantity of fuel. No doubt this result will be accompanied by some diminution in that heavy item in the cost of ammonia soda which is due to loss of ammonia; but still I think that the balance of advantage will be on the side of the Leblanc process. It can only fail to be so by reason of ammonia falling to one-half of its present price. The price of ammonia unquestionably will fall; but I think that increased use of ammonia in agriculture will prevent its price falling to anything like that extent.

Besides, then, being certain of getting his sulphur, by and bye, at half its present price, the English Leblanc soda-maker has thus before him the proverbial "three courses"; only, he must not choose between them, but must adopt them all. He must turn his hydrochloric acid to more uses than he does at present; he must recover and sell his sulphur; and he must distil most of his coal. He will then, I believe, be able, not only to hold his own against the ammonia process, but even to incline the balance in his favour.

It is said that "sweet are the uses of adversity"; and those uses, if not "sweet" in any ordinary sense, are at least unusually wholesome. One of the results of the conditions under which Leblanc soda-makers have had to work of late years has been to lead them to do their utmost to economise fuel and labour in all possible ways, and of the extent to which this has been done some figures which have been supplied to me by one of our leading English manufacturers afford a striking example. They are figures for the ten years 1872 to 1882. In 1872, in the work to which these figures refer, per 100 tons of total products manufactured, 336 tons of coals were consumed and £256 paid in wages: while in 1882, per 100 tons of total products manufactured, only 216 tons of coals were consumed, and only £144 paid in wages; the coal consumption in 1882 being thus only 64 per cent, and the wages in 1882 only 56 per cent, of what they were, upon the same quantity of total products, in 1872. How much more it may yet be possible to do in the way of economising fuel and in adopting labour-saving machinery I cannot judge; but I venture to think that there are a number of little ways in which economies remain to be effected, and of these I will ask permission to give just one example.

I would venture to suggest that the English Leblanc soda-maker, who has taught the Continental Leblanc soda-maker so very much, might in return learn just one or two things from the latter. There can be no doubt that on the Continent, as a rule, and especially in Germany, the Leblanc soda-maker performs to a far less extent than the English Leblanc soda-maker usually does, that useless and costly series of operations which consists in buying salt, transforming it into sodium sulphate, converting that sodium sulphate into carbonate, then converting that carbonate back again into sulphate, and finally giving the sulphate away to his customers, and paying out of his own pocket for casks to put it in. Without entering on the question of the relative proportions of sodium sulphide in English and in German vat-liquors respectively, the ordinary English method of evaporating the vat-liquors and treating the resulting "salts" obviously involves losses of soda which the method of procedure now adopted by all the best German makers wholly avoids. In England, not invariably, but for the most part, the soda-liquors are evaporated by products of combustion passing over their surface, and the resulting "black salts," as they are called, are then "calcined" by products of combustion playing upon and through them. Alike during the evaporation of the liquors, and during the subsequent calcination of the "salts," SO_2 from the products of combustion is absorbed, with the ultimate result that an equivalent of what was soda in the liquors becomes in the final product sodium sulphate. How much soda is habitually lost in this way in England I do not know; but the only careful experiment on the subject with which I am acquainted brought out the loss due to this cause as over two per cent. I cannot think that it averages so much as that; but even if it averages only one per cent, it would be worth avoiding, providing that the cost of avoiding it were not greater than the value of the soda saved. The best German makers do now avoid all loss of soda from absorption of SO_2, and they believe that they gain other important advantages at the same time. They evaporate their soda liquors in pans heated from below; from these pans they fish by automatic mechanical means perfectly white salts; and then, instead of calcining these salts, either in contact with products of combustion or otherwise, they simply dry them in closed iron vessels heated externally, and now usually furnished with mechanical appliances for crushing the soda as it dries, and automatically feeding it into casks. They believe that by these means they effect an appreciable economy, not only of soda, but of fuel and labour too. The mechanical evaporating and fishing pan which they employ—known, from the name of its inventor, as the Thelen pan,—has been adopted in one work in this country, by Messrs. J. C. Gamble and Sons, of St. Helens; but the Thelen apparatus for drying fished salts and delivering the products into casks has not yet been tried in this country at all.

Of course, the product obtained by merely drying fished salts has not the crystalline brilliancy of soda-ash which has been calcined at a high temperature, and is, moreover, probably slightly more bulky than the latter. Bulkiness is objectionable, because it means more casks; but a preference for mere appearance, apart from actual quality, I think consumers could, it it were worth while, be easily educated out of. When the late Karl von Kulmitz founded the chemical works of Saarau, in Silesia, he did so with a view to supplying soda to the soap-makers of Breslau, who at that time were getting all their soda from England. The soda they were supplied with from England was very red, and the first soda made at Saarau was nice and white. When, however, samples of this white soda were sent to Breslau, the soap-makers there would have nothing to to with it. They said that to make good soap they must have *red* soda-ash; and, for a time, Herr Kulmitz was obliged, in order to make his soda saleable, to mix with it a little oxide of iron. He managed after a while to educate his customers out of the habit of requiring that their soda should be red, just as some Continental makers of ammonia-soda have had to educate many of their customers out

of requiring that their soda should be very weak. A little similar education of some of the clients of some of the English Leblanc soda-makers might perhaps put an end to the irrational custom of the latter of adding salt to their soda after they have made it. They have to pay for that salt, they get nothing for it (the mixture being sold at so much per alkalimetric degree), and it increases the cost of their products both for casks and for carriage. As in Lancashire, where this custom of reducing by salt chiefly prevails, a hundredweight of salt costs only about fivepence, —though extra cost for casks and carriage raise that fivepence to at least a shilling, or to fully one per cent on the present selling price of 48 per cent ash,—the matter may be considered too small to be worthy of mention; but in the alkali trade the present is a day of small things, when even pence per ton must be economised at every possible point, and when a shilling a ton may mean all the difference between an actual loss and a small profit. Moreover, it so happens that it is my lot nowadays to visit Continental alkali works much oftener than English alkali works, and when I have made a round among the former, and have found every foreign manufacturer whom I have visited eagerly intent, not only on economising to the uttermost fuel, labour, and raw materials, but also upon making his soda as rich and as pure as possible, in order that it may compete with ammonia-soda, and when I then, on getting home, write to an English alkali-maker to ask what a ton of soda now costs him, in order that I may compare his figures with figures which have been given me abroad, and on receipt of his figures I find that he charges each ton of soda with "one hundredweight of salt for reducing,"—while I know that in some sense or other it must be all right, since my friend of course knows his business very much better than I do, I nevertheless cannot help feeling that there is something here which is behind the times—I cannot help feeling that that ignorance on the part of the customer which makes dilution with salt all right for the moment is not going to last, and that if I were an alkali-maker I should do my best to become one of the first in the new state of things which is fast coming, by beginning at once to take such steps as I have seen Continental ammonia-soda makers take to persuade my customers to take my soda as rich as I make it, and not to require me to increase its cost by adding to it what is of no advantage to them.

Here the present paper might very well have ended, but I know that it is expected by some of the members present that I should say something on the present state of the sulphur recovery question; and I have, therefore, to ask permission to go on a little longer, in order to do so.

The question of the cost of sulphur recovery is one which I do not propose to go into, for the reason, among others, that Mr. Alexander Chance will before long deal with that question before the Liverpool Section of our Society. The experimental plant for the Schaffner and Helbig process which Messrs. Chance Brothers had in operation at their works at Oldbury this time last year, and which continued in operation till June or July, was then stopped, in order to the erection of a new plant, intended to deal with 300 tons of waste per week. This new plant has been recently got to work, and a little later on Mr. Alexander Chance intends to give at Liverpool a full account of its results, and especially of those of them bearing on the commercial aspect of the process. All I will say of it now, therefore, is, that into this new plant the Messrs. Chance have introduced several important improvements which greatly facilitate the working of the process, and that with the results yielded by it, so far, they are perfectly content.

In order to render intelligible some interesting results, relating in some degree to the commercial side of the Schaffner and Helbig process, which were obtained at Oldbury in the autumn, and which I have permission to report, allow me to remind you that the two main operations of that process consist: firstly, in decomposing the calcium sulphide contained in alkali-waste by heating the waste with solution of magnesium chloride, whereby there is obtained, on the one hand, H_2S, and, on the other, solution of calcium chloride holding magnesium hydrate in suspension; and, secondly, in regenerating magnesium chloride for use again by treating that mixture of magnesium hydrate and solution of calcium of chloride by CO_2:—

First Operation.

$$CaS+MgCl_2+2H_2O=H_2S+CaCl_2+MgH_2O_2.$$

Second Operation.

$$CaCl_2+MgH_2O_2+CO_2=MgCl_2+CaCO_3+H_2O.$$

During the construction of their new plant, Messrs. Chance Brothers made a series of quantitative experiments, upon a scale of half a ton of waste per operation, mainly with a view to determining quantitatively the loss of magnesia involved in the process. These experiments were conducted by Mr. Frederick Chance,—a young member of the firm, who has only to fulfil the promise of his youth to take a very high rank among industrial chemists, —and their results are interesting and to a certain extent important. By making a number of successive operations without adding any fresh magnesia or magnesium chloride, and comparing the quantity of magnesium chloride which he had at the end of the series of operations with the quantity which he had at the beginning, Mr. Frederick Chance found that the average loss of magnesia corresponded to 1·05 parts of MgO per 100 parts of waste treated. Now, while in the waste produced at Oldbury there is no magnesia to speak of, a very pure limestone being used there for making black-ash, there is reason to believe that the waste produced in the Newcastle district—the limestone of which district is all more or less magnesian—contains fully enough magnesia to make up this amount of loss, without the addition of any magnesium compound specially for that purpose. All that should be needed, therefore, in the case of Newcastle waste, should be to add from time to time the quantity of calcium chloride necessary to convert into magnesium chloride, by the aid of CO_2, the magnesia actually existing in the waste itself. In other cases, the loss of magnesia in the Schaffner and Helbig process might be made up by replacing two or three per cent of the limestone used for making black-ash by dolomite. This is supposing, of course, that the calcium carbonate recovered in the process is not used again in black-ash making. In proportion as this recovered carbonate can be used again for making black-ash, there will be no loss of magnesia, the magnesia "lost" in one operation coming round again in the next.

The experiments of Mr. Frederick Chance further brought out the important fact that the reaction by wh ch magnesium chloride and calcium carbonate are recovered takes place—at any rate under the conditions under which he operated, *i.e.*, under a pressure of twenty pounds per square inch,– quite as readily when the mixture treated by CO_2 is hot as when that mixture is cold. It has been supposed that that reaction depends upon the formation of bicarbonate of magnesia, in which case the mixture in question would have required to be cooled before being treated by CO_2, and so to cool it would have been at least troublesome. It seems, however, that the reaction in question is really a reaction between $CaCl_2$ and $MgCO_3$. This result is confirmed by the result obtained by Dr. Hewitt by simply mixing with solution of $CaCl_2$ an equivalent of the carbonate of magnesia of the shops. He obtained in that way a decomposition of about 80 per cent of his calcium chloride, and it is probable that the carbonate of magnesia he employed did not contain more than that percentage of $MgCO_3$.

Mr. Frederick Chance further lighted upon a very curious fact, which is valuable as affording to the workmen a simple and ready indication of the moment at which the regeneration of the magnesium chloride has become complete. In the mixture operated upon there is always a little ferrous sulphide. This ferrous sulphide is not acted upon by CO_2 so long as there is any free magnesia present, but it is attacked so soon as all magnesia present has

become carbonated, with the result of sending iron into solution as acid ferrous carbonate. The presence of the iron which thus comes into solution can be very readily detected, and the moment it appears the workmen in charge know that it is time to stop injecting CO_2.

In the South of France experiments are now being made, at my instance, with a modification of the Schaffner and Helbig process. The first time I visited Cornwall, now very many years ago, I was on one occasion at a dinner-table at which I was asked to name "the four Cornish minerals." To name two of them was not difficult, but my endeavours to name the other two only created most Homeric laughter. At length I was informed that "the four Cornish minerals" are "fish, copper, potatoes, and tin." Cornwall being a mining county, for a Cornishman every natural production which he turns to useful account is a "mineral." At a banquet given by him at Giraud, in May last, to the members of the "Société de l'Industrie Minérale,"—the French "Iron and Steel Institute,"—M. Pechiney, addressing miners and metallurgists, similarly spoke of sea-water as "notre minérai à nous;" and the object of the modification in question is to turn to account in two ways one of the constituents of that extremely complex liquid ore, namely, its magnesium chloride. Most of those in France who make salt from sea-water content themselves with obtaining therefrom only common salt, but M. Pechiney treats the mother-liquors from which as much NaCl as possible has been crystallised out for the further obtainment from them of sodium sulphate, magnesium sulphate, and potassium chloride, and his final residue is a saturated solution of magnesium chloride, containing no other body except magnesium bromide. It has seemed to me that this magnesium chloride might be utilised at once for the recovery of sulphur from soda-waste, and as a source of magnesia for sale as such. When alkali-waste, however, is treated directly by solution of magnesium chloride, the magnesium hydrate, which is one of the products of the reaction which takes place, is obtained in admixture with all the numerous bodies other than calcium sulphide which were contained in the waste treated. When the magnesium hydrate is to be employed for the regeneration of magnesium chloride, this presence with it of foreign bodies does not matter; but in cases in which regeneration of the magnesium chloride used is not necessary, while it is desired to obtain magnesium hydrate for sale, the presence of foreign bodies with the magnesium hydrate must be avoided. I propose to avoid it by taking advantage of a reaction which is known as Kraushaar's, from its having been first published, in *Dingler's Journal* for 1877, by Dr. Kraushaar, of Thann, but which was really discovered by Mr. Helbig, at Aussig, and turned by him to practical account there as early as 1874. This is the reaction which takes place when alkali-waste is heated with water under pressure. It is a reaction of two of water upon two of calcium sulphide, giving one of calcium hydrate and one of calcium sulphydrate. The calcium sulphydrate is obtained in solution, and if this solution be separated from the calcium hydrate and other bodies which it at first holds in suspension, on then running into it solution of magnesium chloride there is obtained, on the one hand, H_2S, and on the other, magnesium hydrate, almost chemically pure. And it is to be noted that, whereas when alkali-waste is treated directly with solution of magnesium chloride only one of H_2S is obtained for each equivalent of $MgCl_2$ which enters into reaction, by first getting the sulphur of the waste into the state of calcium sulphydrate two equivalents of H_2S are obtained for each equivalent of magnesium chloride decomposed.

At one time I had some hope that one might take advantage in England of this reaction of two of water upon two of waste, to the end of reducing by one-half the quantity of magnesium chloride to be employed, and consequently the quantity of that body to be recovered, per given quantity of alkali-waste treated. Mr. Chance was so obliging as to make some experiments on this point at Oldbury, and Mr. Helbig made others at Aussig, and the result of both series of experiments went to show that the idea is not applicable, or at any rate not applicable with any great advantage, when the magnesium chloride employed has to be regenerated. The reason is that the whole of the sulphur of the calcium sulphide of the waste which is heated with water under pressure does not come into solution unless a certain minimum quantity of water be used. This quantity of water is not too great to permit of the method being employed with advantage when the magnesium chloride has not to be recovered. But, when it has to be recovered, all this water would have afterwards to be driven off by evaporation, or the regenerated magnesium chloride would be impracticably dilute; and the cost of this additional evaporation would probably balance the economy due to halving the quantity of magnesium chloride to be dealt with.

Some attention has been drawn recently to a second Austrian method of recovering sulphur from alkali-waste: a method proposed by Herr Opl, of the chemical works of Hruschau, in Moravia. This gentleman proposes to mix waste with water, to treat the mixture with CO_2 and so drive off H_2S from it, and then to pass this H_2S into more mixture of waste with water, in order that it shall be absorbed by the calcium sulphide of this second quantity of waste with formation of solution of calcium sulphydrate, which could then be treated in any one of several ways. This proposal seems to me defective, for the reason, among others, that I do not see how it would be practicable to avoid sending an excess of CO_2 into the second quantity of mixture of waste and water, which excess of CO_2 would react on some of the calcium sulphydrate formed in that second quantity of such mixture, driving off H_2S, and so occasioning both loss of sulphur and nuisance. Certainly, Herr Opl's method of getting the sulphur of alkali-waste into solution as calcium sulphydrate cannot, I think, compete with the simpler method of heating the waste with water under pressure.

Here, at last, I draw this too long paper to a close. I have had to show in it that the immediate future of the English Leblanc soda industry is somewhat gloomy; but I trust that I have shown also reason to believe that sufficient attention to the complete utilisation of all raw materials is yet capable of saving it. Very much has yet to be done before it will be placed once more on a satisfactory basis; but *nil desperandum!* Patient courage and wisely-directed labour will bring all right again in time. A French Leblanc soda-maker, discussing in Paris, recently, "l'affaire de Rio Tinto," spoke very hopelessly at first, but suddenly his countenance brightened, and he said: "*Mais, courage!* This is not the first time, nor the second, since I have been in the trade, that we have been menaced with apparently unavoidable ruin; but we have always pulled through before, and we will pull through again." That is a spirit on which we in England specially pride ourselves; and in whatever "pluck," combined with intelligence, can do,—and in this case I believe that they can do all that is required,—I am confident that my countrymen will not be left behind.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 15, 1883.

Dr. GILBERT, F.R.S., President, in the Chair.

IT was announced that a ballot for the election of Fellows would be held at the next meeting (March 1).

The following certificate was read for the first time:—W. H. Cameron.

The list of Officers as proposed by the Council was read from the Chair: Prof. G. D. Liveing and Dr. A. Voelcker

are proposed as Vice-Presidents instead of Prof. J. Dewar and A. V. Harcourt, who retire; in the Council, Prof. Dittmar, Dr. W. R. E. Hodgkinson, Messrs. D. Howard and R. Meldola replace Dr. T. E. Thorpe and Messrs. F. D. Brown, J. M. Thomson, and W. Thorp; Drs. Thorne and Hodgkinson and Mr. D. Howard were elected auditors.

The SECRETARY then read the following papers:—

"*On some Derivatives of Diphenylene-ketone Oxide*," by A. G. PERKIN. While preparing the above substance from salicylic acid and acetic anhydride, the presence of a small quantity of another body was detected in the washings. This substance the author has separated as transparent satiny plates containing 75·2 per cent C, 3·9 per cent H. Its formula has not yet been settled. By the action of a cold mixture of equal parts of nitric and sulphuric acids, and by the action of fuming nitric acid, a nitro-body was formed, $C_{15}H_6(NO_2)O_2$. It is very slightly soluble in boiling alcohol, and melts at 262° C. By the action of tin and hydrochloric acid on dinitro-diphenylene-ketone oxide, suspended in alcohol, a diamido-body is produced, $C_{13}H_6(NH_2)_2O_2$; it was obtained in flat orange-coloured needles. This base forms a hydrochloride and a platinum salt, which were analysed. Diphenylene-ketone oxide dissolves in cold Nordhausen acid unchanged, but on heating the solution and treating with barium carbonate, a salt was obtained having the formula $C_{13}H_6O_2Ba(SO_3)_2$. Bromine, when heated in a sealed tube with diphenylene-ketone oxide, forms a dibromo-body, $C_{13}H_6Br_2O_2$.

"*On α-Ethyl-valero-lacton, α-Ethyl-β methyl-valero-lacton, and on a Remarkable Decomposition of β-Ethyl-aceto-succinic Ether*," by S. YOUNG. Fittig and Krafft (*Annalen*, 208, 71) prepared a hepto-lacton of unknown constitution. The author, at the suggestion of Prof. Fittig, undertook the preparation of a hepto-lacton of known constitution. A mixture of 10 grms. of sodium, 100 grms. of alcohol, 58 grms. of aceto-acetic ether, and 87 grms. of α-bromo-butyric ether, was heated in a water-bath for two days. The author could not obtain a product of constant boiling-point. About 12 grms. of the portion boiling at from 250° to 260° was boiled with twice its weight of 33 per cent hydrochloric acid. The resulting product was principally α-ethyl-β-aceto-propionic acid, which was extracted with ether, and the latter distilled off. The residue partially crystallised at low temperatures. A portion was warmed with sodium amalgam, acidified with sulphuric acid, and boiled, made alkaline with potassium carbonate, and extracted with ether; the ether extract on distillation gave a residue which eventually, after fractionation, proved to be the lacton, boiling at 219·5°. Analysis indicated the formula $C_7H_{12}O_2$. It did not solidify in a mixture of snow and salt. On dissolving this substance in the smallest possible quantity of ice-cold water, a clear solution was obtained, which became turbid at 17° up to 90°, &c. By boiling the lacton with barium hydrate, barium and ethyl-oxyvalerate was prepared: the silver salt was also obtained and analysed. When either salt is decomposed by an acid a mixture of lacton and oxy-acid is formed. On preparing larger quantities of the crystalline acid, which the author calls ketolactonic acid, the distillate at higher temperatures, above 265°, yielded proportionately more crystals than that between 250° to 260°, so that the decomposition apparently takes place during distillation, and not during saponification. The barium and silver salts of this ketolactonic acid were prepared and analysed. By the action of barium hydrate on ketolactonic acid a derived acid was prepared, whose silver salt had the composition $C_8H_{10}O_5Ag_2$. Thorne obtained by the saponification of β-ethyl-aceto-succinic ether, α-ethyl-β-aceto-propionic acid and ethyl-succinic acid. The author separated, in addition, this new ketolactonic acid. α-ethyl-β-methyl-valerolacton was also prepared by the distillation of β-ethyl-aceto-methyl-succinic ether. Thorne, by the distillation of α-ethyl-β-propionic acid, obtained an anhydride which he stated to be insoluble in water. The author has repeated these experiments, and obtained the anhydride, which is, however, slightly soluble in water. In conclusion, the constitution of ketolactonic acid is discussed.

Dr. THORNE said that he was able to distil the β-ethyl-aceto-succinic ether *in vacuo* at 263° to 264° without decomposition. As to the anhydride, he had since found that it was slightly soluble in water. At the time he first prepared the substance he had but a very small quantity at his disposal.

The Society then adjourned to March 1, when a ballot for the election of Fellows will be held, and the following paper read:—"On some Derivatives of the Isomeric $C_{10}H_{14}O$ Phenols," by Dr. Armstrong and E. H. Rennie.

PHYSICAL SOCIETY.

Annual General Meeting, February 10th, 1883.

Professor FULLER in the Chair.

NEW Officers elected for the year:—

President—Prof. R. B. Clifton, M.A., F.R.S.

Vice-Presidents—Sir W. Thomson, F.R.S.; Prof. G. C. Foster, F.R.S.; Dr. J. Hopkinson, F.R.S.; Lord Rayleigh, F.R.S.; Prof. W. C. Roberts, F.R.S.

Secretaries—Prof. A. W. Reinold, M.A.; Mr. Walter Baily, M.A.

Treasurer—Dr. E. Atkinson.

Demonstrator—Prof. F. Guthrie, F.R.S.

Other Members of Council—Prof. W. G. Adams, M.A., F.R.S.; Prof. W. E. Ayrton, F.R.S.; Mr. Shelford Bidwell, M.A., LL.B.; Mr. W. H. M. Christie, M.A., F.R.S.; Prof. F. Fuller, M.A.; Mr. R. T. Glazebrook, M.A., F.R.S.; Mr. R. J. Lecky, F.R.A.S.; Prof. O. J. Lodge, D.Sc.; Mr. Hugo Müller, Ph.D., F.R.S.; Prof. J. Perry.

New Member—Prof. Blyth, of Anderson's College, Glasgow.

Prof. SILVANUS P. THOMPSON explained his new graphical method of showing Jacobi's law of maxium rate of working, and Siemens's law of efficiency for dynamo-electric machines. This has been fully explained in the *Philosophical Magazine*, and in the Cantor Lectures on "Dynamo-Electric Machinery" delivered by Prof. Thompson.

Prof. W. G. ADAMS pointed out the advantages of a graphic system of the kind.

CORRESPONDENCE.

THE DETERMINATION OF NITRIC ACID IN MANURES BY THE CRUM METHOD.

To the Editor of the Chemical News.

SIR,—Referring to Mr. Shepherd's paper in the CHEMICAL NEWS, vol. xlvii., p. 75, describing the determination of nitric acid in manures by the Crum method, he directs that the weighed portion "be extracted with boiling water and filtered, the filtrate and washings evaporated to a small bulk, &c." Having used the method for a long time past, my experience is that filtration is unnecessary, and boiling and evaporating decidedly to be avoided, as manures invariably contain sufficient free acid to react upon the nitrate at a temperature above 90° C. I simply extract about 50 grains with *warm* water, make the solution up to a certain measure (say 1000 grains), and take 100 grains of this for a determination. I have also always found an *equal* volume of o. v. ample.

Mr. Shepherd further on says—"Usually some carbonic acid and other gases are given off" on mixing the liquids. I cannot understand from whence the carbonic acid will

come, and in his case an alkaline carbonate. I think usually he will find the other gases largely predominate, and consist essentially of oxides of nitrogen.

With regard to compensating for the weight of the column of acid, this can be accurately done by placing water in the cup or funnel of the nitrometer and cautiously opening the stopcock. Should the gas be under pressure from within, the bubble which rises may be caught in the aperture of the stopcock, the pressure reversed, and the bubble returned to the nitrometer, together with some water, then either letting water cautiously in until the levels are equalised, or by raising the mercury reservoir until the water in the funnel remains stationary on opening the stopcock.—I am, &c.,

H. B. Yardley.

Odam's Wharf, Victoria Docks,
London, February 19, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 1, January 2, 1883.

Memoir on the Vision of Material Colours in Rotatory Movement, and on the Respective Speed, estimated in Figures, of Circles of which one Diametral Half is Coloured and the other Half White; Speeds Corresponding to three Periods of their Movement, from the Extreme Speed to Rest.—E. Chevreul.—This paper is not capable of useful abstraction.

Researches on the Hyponitrites: First Part—Chemical Researches.—MM. Berthelot and Ogier.—Silver hyponitrite has received the formula NO_2Ag. The authors deduce from their analyses the formula $N_2O_5Ag_2$. Hyponitrous acid is, therefore, a sesqui-oxide of nitrogen, having, in the anhydrous state, the composition N_2O_3.

Decomposition of Formic Acid by the Effluve.—M. Maquenne.—The apparatus used consisted of a Berthelot's effluve tube containing 10 to 15 grms. of monohydrated formic acid. The results are carbon monoxide and dioxide and hydrogen, and some traces of carbides. The results are identical with those obtained by M. Berthelot on decomposing formic acid by heat alone in a closed vessel.

Pyro-sulphuryl Chloride.—J. Ogier.—The author, in common with M. Rosenstiehl, and in opposition to M. Konowaloff, finds that the vapour-density of sulphuryl chloride is one-half less than the law of Avogadro would require. He refutes the explanation proposed by M. Konowaloff to account for the discrepancy of their respective determinations. He shows that the substance upon which he operated was certainly pyro-sulphuryl chloride, and that it did not contain a notable quantity, such as three-quarters of the compound S_2O_6HCl; that the substance weighed in the density flasks had the same composition as that taken for the experiment, and that it had not been dissociated.

Existence of Zinc in a State of Diffusion in Dolomitic Districts.—M. Dieulafait.—From the presence of ammonia, and occasionally of bitumen, in dolomites the author concludes that they are not merely sedimentary rocks, but that they have been produced in waters very rich in organic matters, *i.e.*, in land-locked bays or in estuaries. He has previously shown that zinc is still being concentrated in the estuaries of the modern era, and points to the close connection between magnesium and zinc. Hence it might be expected, as actually occurs, that zinc would be found in magnesian rocks.

No. 2, January 8, 1883.

Researches on the Hyponitrites: Second Part—Calorimetric Measurements.—MM. Berthelot and Ogier.—A thermo-chemical memoir which does not admit of useful abridgment.

Natural Formation of Manganese Dioxide, and Certain Reactions of the Peroxides.—M. Berthelot.—The author remarks that the opposition between those metallic peroxides which furnish oxygenated water under the influence of acids and those which do not, is the real experimental foundation of the celebrated theory of ozonides and antozonides. It is explained by thermic considerations correlative to those which determine the displacement of carbonic acid in the carbonates by free oxygen.

Examination of the Analogy between the Electro-Chemical and the Hydro-dynamical Rings and the Curves $\Delta V = O$.—M. Ledieu.—The author points out certain fundamental differences between the two classes of rings.

Influence of Refrigeration upon the Value of the Maximum Pressures developed in Closed Vessels by Explosive Gases.—M. Vieille.

Remarks on the Expression of Electric Magnitudes in the Electrostatic and Electromagnetic Systems, and the Relations thence Deduced.—MM. E. Mercadier and Vaschy.—Two mathematical papers, not susceptible of useful abstraction.

Phosphorography of the Ultra-Red Region of the Solar Spectrum: Wave-lengths of the Principal Rays.—Henri Becquerel.—The principal facts resulting from the author's researches are, besides the determination of new rays in the solar spectrum and of their wave-length, the observation in the ultra-red spectrum of maxima and minima of extinction peculiar to various phosphorescent substances.

Solar Photometry.—M. Crova.—The author gives the intensity of the sun's light in a clear sky at about 8500 carcels.

Manganese in Dolomitic Regions: Origin of the Nitric Acid sometimes found in Native Manganese Peroxides.—M. Dieulafait.—The author finds that manganese as well as zinc is linked to magnesia. In 144 dolomitic rocks in which he had observed zinc, manganese was likewise detected, whilst in 42 non-magnesian calcareous rocks it was absent. There are two classes of manganese ores; the former, derived from the action of sea-water upon the primordial rocks, are invariably associated with barium sulphate. The manganese ores of the second class are always poor in baryta.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 4, 1882.

General Analytical Methods, Operations, Apparatus, and Reagents.—Concerning the hygroscopic power of various substances, W. Müller-Erzbach finds that phosphoric anhydride, concentrated sulphuric acid, and dehydrated potassa differ little in their power of attracting water. Caustic soda and calcium chloride differ mutually little, but do not retain water as firmly as phosphoric anhydride or potassa.

A. Rollett describes a "polarispectro-microscope." It consists of an ordinary microscope with a small direct vision spectroscope placed below the stage, and beneath this, again, a polarising prism.

Fuch and Ricco propose modified prisms, which cannot be described without the aid of the accompanying figures.

Phenacetoline, proposed as an alkalimetric indicator by Paul Degener, is tinged very faintly yellowish by caustic alkalies and alkaline earths; with the carbonates it forms a full red compound, soluble in case of alkalies, but insoluble in the alkaline earths. With acids, phenacetoline

is coloured a distinct golden yellow. With sodium sulphide it behaves as with sodium carbonate, and is also reddened by ammonia.

K. Tumsky has experimented with phenol phthaleine as an indicator, and infers that it is less sensitive than litmus, and is not affected by ammoniacal vapours and dilute solutions of alkaline carbonates.

O. Miller, S. Prochorow, and P. Wisocky pronounce phenol phthaleine a good indicator when pure, but useless when impure.

Fr. Stolba proposes the following method for the preparation of azolitmine: Clean linen or cotton cloth is saturated in common tincture of litmus, washed in common water, and then in distilled water. The colour is then stripped by a passage in distilled water to which a few drops of very weak soda-lye have been added. The deep blue liquid thus obtained is cautiously neutralised by the addition of dilute sulphuric acid.

Preparation of Metallic Copper for Organic Analysis.—Th. Weyl.—The author exposes cupric oxide, moderately heated in a combustion-tube, to the vapour of formic acid.

Chemical Analysis of Inorganic Bodies.—E. Hintz.

Spectrum of Magnesium.—G. D. Liveing and J. Dewar.—From the *Proceedings of the Royal Society*.

Sensitive Reagent for Gaseous Ammonia.—Gustav Kroupa.—The author dissolves magenta in water and adds dilute sulphuric acid until the yellowish colour passes into a yellowish brown. Unsized paper is saturated with this solution, and then appears yellow, but if exposed to the vapour of ammonia it takes a crimson colour. The paper must be preserved in stoppered bottles.

Solubility of Strontia in Water.—C. Scheibler and D. Sidersky.—The authors find that a saturated solution of strontia (hydrated) at 0° contains 0·35 per cent SrO, but at 101·2°, 19·34 per cent.

Separation of Magnesia from Lime, Ferric Oxide, and Alkalies.—H. Hager.—Will be inserted in full.

Detection of Cobalt in Presence of Iron and Nickel. C. H. Wolff.—For the quantitative determination of minimum quantities of cobalt C. H. Wolff recommends the characteristic absorption-spectrum of the blue solution obtained on mixing a neutral alcoholic solution of cobaltous chloride or nitrate with an alcoholic solution of ammonium sulphocyanide. In order to apply this process to the detection of cobalt in presence of iron and nickel, H. W. Vogel combines it with C. Zimmerman's method of separation, based on the fact that from a mixed solution, containing nickelous, cobaltous, and ferric sulphocyanides, the iron is thrown down as ferric hydrate by the addition of neutral sodium carbonate. Vogel adds to the solution, sodium carbonate till the red colour disappears, filters, and shakes the filtrate in a test-tube with a mixture of equal volumes of amylic alcohol and ether. This mixture takes up the cobaltous sulphocyanide, and separates as a blue stratum floating above the watery liquid. If nickel is also present the ethereal liquid is not blue, but green. If the liquid is examined in the spectroscope the presence of cobalt is distinguished by the absorption-band between C and D.

Determination of Small Quantities of Arsenic in Sulphur.—H. Schäppi.—The sulphur, finely ground, is covered with hot water, to which a few drops of nitric acid have been added in order to remove calcium chloride and sulphate, and to decompose calcium sulphide. It is digested, filtered, and washed till the washings do not react acid. The sulphur is then digested for a quarter of an hour at 70° to 80° with water containing a few drops of pure ammonia. The solution, containing all the arsenic sulphide, is mixed with silver nitrate, and all the sulphur present as arsenic sulphide is deposited as silver sulphide. For its determination the liquid is acidulated with dilute nitric acid, dissolved in hot nitric acid, hydrochloric acid is added, and the precipitated silver chloride is weighed. Three equivalents of silver chloride correspond to one equivalent of arsenic tersulphide. According to Hager arsenic may be present in sulphur as arsenious acid. In this form it will escape determination by the process in question.

Determination of Tungstic Acid in Presence of Alkalies.—Wolcott Gibbs.—From the *American Chemical Journal*.

Determination of Phosphoric Acid.—R. Finkener.—The author proposes a method for the direct determination of phosphoric acid from the weight of the phosphomolybdic precipitate. The following conditions must be observed in precipitation: The solution must contain a sufficiency of free nitric acid. The molybdic solution added must be fourfold the volume of the phosphoric solution to be precipitated, and at least one-third of the molybdic acid added must be in excess of the quantity required for combination with the phosphoric acid. In every 100 c.c. of the volume of liquid after the addition of the molybdic solution must be dissolved 25 grms. ammonium nitrate. The precipitate of ammonium molybdate is filtered after standing for twelve hours, and is washed with a 20 per cent solution of ammonium nitrate, to which at the beginning of the washing 1-30th of its bulk of nitric acid is added. After removal of the greater part of the ammonium nitrate by means of water the contents of the filter are rinsed into a porcelain crucible, the matter adhering to the paper is dissolved in hot dilute ammonia, the solution is concentrated by evaporation, an excess of nitric acid is added, the solution is poured into the porcelain crucible, the liquid is evaporated away, and the ammonium nitrate expelled by gently heating over a flame placed below a wire gauze. The volatilisation of the ammonium nitrate is found to be complete when a cold watch-glass placed over the crucible is not clouded. The ammonium phospho-molybdate is not decomposed if a needlessly high temperature is avoided. The residue is hygroscopic, and must be cooled in the desiccator over sulphuric acid, and quickly weighed in a covered crucible. The residue is said to contain 3·794 per cent phosphoric acid. O. Hehner, in the *Analyst* (iv., p. 23), criticises this process, and proposes a modification. A. Atterberg has determined the conditions in which the most rapid and complete separation of the ammonium phospho-molybdate can be effected. He finds that by boiling the solution with molybdic acid solution the phosphoric acid is precipitated in a satisfactory manner. The boiling is effected in a beaker of moderate size, stirring continually to prevent bumping. The heat is obtained from a naked lamp flame beneath a wire gauze. The precipitate settles very quickly, and can be at once submitted to further treatment.

Determination of Phosphoric Acid combined with Lime and Magnesia.—E. Perrot.—From the *Comptes Rendus*.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—The Chemical Laboratory of this place still enjoys a very large attendance. Besides the Director, Geh. Hofrath, and Dr. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect Brahm. The Assistants are twelve in number in the Private Laboratory, two in the Instruction Laboratory, and in the Versuchsstation two in the winter term 1882-83. In this term there were 60 students on the books. Of these 44 were from Germany, 5 from England, 5 from North America, 1 from South America, 1 from Luxemburg, 1 from Austro-Hungary, 1 from Sweden, 1 from Russia, and 1 from Spain. During the last term, besides the scientific researches, a great number of analyses were undertaken in the Laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

British Mining.—Messrs. Crosby Lockwood and Co. have in active preparation and will publish, it is hoped, in the autumn, an extensive work on British Mining by Mr. Robert Hunt, the well-known Keeper of Mining Records. The book will, we are informed, comprise a thoroughly practical treatise on the metalliferous mines and minerals of the United Kingdom, dealing comprehensively with the theories of mineral deposits, the history of mines, their practical working, and the future prospects of British mining industry. The work will be fully illustrated. A most intimate connection with the mines and miners of the United Kingdom, extending over nearly forty years, and the collection and compilation of the "Mineral Statistics" for thirty-five years, must necessarily have given Mr. Hunt an insight into the theory and practice of all that relates to metalliferous mining which few other persons can possess, and we may therefore expect that the subject will receive the most ample treatment at his hands.

MEETINGS FOR THE WEEK.

SATURDAY, 24th .—Physical, 3. "Optical Combinations of Crystallin Films," by Lewis Wright. "Experimental Demonstration of the Vorticle Theory of the Formation of a Solar System," by Philip Braham.
MONDAY, Feb. 26.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field.
TUESDAY, 27th.—Royal Institution, 3. "The Supreme Discoveries in Astronomy (The Sun no more than a Star, the Stars no less than Suns)," by Professor R. S. Ball.
— Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Society of Arts, 8. "Egypt, Present and to Come," by Mr. Robert W. Felkin.
WEDNESDAY, 22th.—Society of Arts, 8. "The Increasing Destruction of Life and Property by Fire—What is the Remedy?" by Mr. Cornelius Walford.
THURSDAY, March 1st.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
— London Institution, 7.
— Royal, 4.30.
— Medical and Chirurgical, 8. (Anniversary).
— Chemical, 8. Ballot for Election of Fellows. "On some Derivatives of the Isomeric $C_{10}H_{14}O$ Phenols," by H. E. Armstrong Ph.D., and E. H. Rennie.
FRIDAY, 2nd.—Royal Institution, 8. "Meters for Power and Electricity." by Mr. C. V. Boys, at 9.
— Society of Arts, 8. "Agriculture in Lower Bengal, with some Notice of Tenant-Right, &c." by W. S. Seton-Karr.
Geologists' Association, 8.
SATURDAY, 3rd.—Royal Institution, 3. "Singing, Speaking, Stammering," by Dr. W. H. Stone.

TO CORRESPONDENTS.

S. B.—We are not able to give the desired information. An advertisement in our columns would doubtless obtain it.

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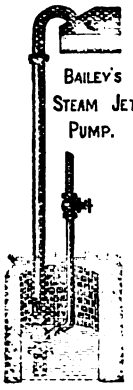

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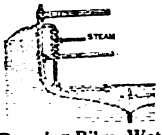

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1214.

NOTE ON TERRESTRIAL RADIATION.*

By JOHN TYNDALL, F.R.S.

On Hind Head, a fine moorland plateau about three miles from Haslemere, with an elevation of 900 feet above the sea, I have recently erected a small iron hut, which forms, not only a place of rest, but an extremely suitable station for meteorological observations. Here, since the beginning of last November, I have continued to record from time to time the temperature of the earth's surface as compared with that of the air above the surface. My object was to apply, if possible, the results which my experiments had established regarding the action of aqueous vapour upon radiant heat.

Two stout poles about 6 feet high were firmly fixed in the earth 8 feet asunder. From one pole to the other was stretched a string, from the centre of which the air thermometer was suspended. Its bulb was 4 feet above the earth. The surface thermometer was placed upon a layer of cotton-wool, on a spot cleared of heather, which thickly covered the rest of the ground. The outlook from the thermometers was free and extensive; with the exception of the iron hut just referred to there was no house near, the hut being about 50 yards distant from the thermometers.

On November 11th, at 5·45 P.M., these were placed in position, and observed from time to time afterwards. Here are the results:—

6 P.M.	..	Air 36° F.	..	..	Wool 26° F.		
8.10 ,,	..	,, 36	..	..	,, 25		
9.15 ,,	..	,, 36	..	..	,, 25		

Air almost dead calm, sky clear, and stars shining.

November 12th, the wind had veered to the east, and was rather strong. The thermometers, exposed at 5 P.M., yielded the following results:—

5.15 P.M.	..	..	Air 38°	..	..	Wool 33°	
5.45 ,,	..	..	,, 38	..	..	,, 34	
6.45 ,,	..	..	,, 38	..	..	,, 35	
9 ,,	..	..	,, 39	..	..	,, 36	

During the first and last of these observations the sky was entirely overcast, during the other two a few stars were dimly visible.

On November 13th, 25th, and 26th, obversations were also made, but they presented nothing remarkable.

It was otherwise, however, on December 10th. On the the morning of that day the temperature was very low, snow a foot deep covered the heather, while there was a very light movement of the air from the north-east. Assuming aqueous vapour to play the part that I have ascribed to it, the conditions were exactly such as would entitle us on *à priori* grounds to expect a considerable waste of the earth's heat. At 8.5 A.M. the thermometers were placed in position, having left the hut at a common temperature of 35°. The cotton-wool on which the surface thermometer was laid was of the same temperature. A single minute's exposure sufficed to establish a difference of 5° between the two thermometers. The following observations were then made:—

8.10 A.M.	..	..	Air 29°	..	..	Wool 16°	
8.15 ,,	..	..	,, 29	..	..	,, 12	

Thus, in ten minutes, a difference of no less than 17° had established itself between the two thermometers.

Up to this time the sun was invisible: a dense dark cloud, resting on the opposite ridge of Blackdown, virtually retarded his rising.

8.20 A.M.	..	..	Air 27°	..	..	Wool 12°	
8.30 ,,	..	..	,, 26	..	..	,, 11	
8.40 ,,	..	..	,, 26	..	..	,, 10	
8.45 ,,	..	..	,, 27	..	..	,, 11	
8.50 ,,	..	..	,, 29	..	..	,, 11	

During the last two observations, the newly risen sun shone upon the air thermometer. As the day advanced the difference between air and wool became gradually less. From 18° at 8.50 A.M., it had sunk at 9.25 to 15°, at 9.50 to 13°, while at 10.25, the sun being unclouded at the time, the difference was 11°; the air at that hour being 31° and the wool 20°.

In the celebrated experiments of Patrick Wilson, the greatest difference observed between a surface of snow and the air 2 feet above the snow, was 16°; while the greatest difference noticed by Wells during his long continued observations, fell short of this amount. Had Wilson employed swandown or cotton-wool, and had he placed his thermometer 4 feet instead of 2 feet above the surface, his difference would probably have surpassed mine, for his temperatures were much lower than those observed by me. There is, however, considerable similarity in the conditions under which we operated. Snow in both cases was on the ground, and with him, as with me, there was a slight movement of the air from the north-east. The great differences of temperature between earth and air which both his observations and mine reveal, are due to a common cause, namely, the withdrawal of the check to terrestrial radiation which is imposed by the presence of aqueous vapour.

Let us now compare these results with others obtained at a time of extreme atmospheric serenity, when the air was almost a dead calm, and the sky without a cloud. At 3.30 P.M., January 16th, the thermometers were placed in position, and observed afterwards with the following results:—

3.40 P.M.	..	..	Air 43°	..	..	Wool 37°	
3.50 ,,	..	..	,, 42	..	..	,, 35	
4 ,,	..	..	,, 41	..	..	,, 35	
4.15 ,,	..	..	,, 40	..	..	,, 34	
4.30 ,,	..	..	,, 38	..	..	,, 32	
5 ,,	..	..	,, 37	..	..	,, 28	
5.30 ,,	..	..	,, 37	..	..	,, 30	
6 ,,	..	..	,, 36	..	..	,, 32	

These observations, and especially the last of them, merit our attention. There was no visible impediment to terrestrial radiation. The sky was extremely clear, the moon was shining; Orion, the Pleiades, Charles's Wain, including the small companion star at the bend of the shaft, the north star, and many others, were clearly visible. On no previous occasion during these observations had I seen the firmament purer; and still, under these favourable conditions, the difference between air and wool at 6 P.M. was only 4°, or less than one-fourth of that observed on the morning of the 10th of December.

We have here, I submit, a very striking illustration of the action of that invisible constituent of the atmosphere, to the influence of which I drew attention more than twenty-two years ago. On the 10th of December the wind was light from the north-east, with a low temperature. On the 16th of January it was very light from the south-west, with a higher temperature. The one was a dry air, the other was a humid air; the latter, therefore, though of great optical transparency, proved competent to arrest the invisible heat of the earth.

The variations in the temperatures of the wool recorded in the last column of figures are, moreover, not without a cause. The advance of temperature from 28° at 5 P.M. to 32° at 6 P.M., is not to be accounted for by any visible change in the atmosphere, or by any alteration in the motion of the air. The advance was due to the intrusion

* A Paper read before the Royal Society, Feb. 8, 1883.

at 6 P.M. of an invisible screen between the earth and firmament.

As the night advanced, the serenity of the air became, if possible, more perfect, and the observations were continued with the following results:—

6.30	P.M.	..	..	Air 36°	..	..	Wool 31°
7	,,	..	..	,, 36	..	..	,, 28
7.30	,,	..	..	,, 35½	..	..	,, 28
8	,,	..	..	,, 35	..	..	,, 26
8.30	,,	..	..	,, 34	..	..	,, 25
9	,,	..	..	,, 35	..	..	,, 27
10	,,	..	..	,, 35	..	..	,, 28
10.30	,,	..	..	,, 35	..	..	,, 29

After this last observation, my notes contain the remark "Atmosphere exquisitely clear. From zenith to horizon cloudless all round."

Here, again, the difference of 4° between the temperature of the wool at 8.30 P.M., and its temperature at 10.30 P.M., is not to be referred to any sensible change in the condition of the atmosphere.

The observations were continued on January 17th, 23rd, 24th, 25th, and 30th; but I will confine myself to the results obtained on the evening of the day last mentioned. The thermometers were exposed at 6.45 P.M., and by aid of a lamp read off from time to time afterwards.

7.15	P.M.	..	..	Air 32°	..	..	Wool 26°
8	,,	..	..	,, 31	..	..	,, 26
9.30	,,	..	..	,, 31	..	..	,, 27

During these observations the atmosphere was very serene. There was no moon, but the firmament was powdered with stars. The serenity, however, had been preceded by heavy rain, which doubtless had left the atmosphere charged with aqueous vapour. The movement of the air was from the south-west and light. Here again, with an atmosphere at least as clear as that on December 10th, the difference between air and wool did not amount to one-fourth of that observed on the latter occasion.

The results obtained on February 3rd were corroborative. The thermometers were exposed at 6.15 P.M.

7.15	P.M.	..	..	Air 34°	..	..	Wool 28°
8.25	,,	..	..	,, 34	..	..	,, 30

Here again, the difference between air and wool is only 4 degrees, although the sky was cloudless, and the stars were bright. The movement of the air was from the south-west and light.

On the forenoon of this day there had been a heavy and persistent rain storm. Heavy rain and high wind also occurred on the night following. The serene interval during which the observations were made lay, therefore, between the two storms. Doubtless the gap was well filled with pure aqueous vapour.

Further observations were made in considerable numbers, but they need not here be dwelt upon, my object being to illustrate a principle rather than to add to the multitudinous records of meteorology. It will be sufficient to say, that with atmospheric conditions sensibly alike, the waste of heat from the earth varies from day to day; a result due to the action of a body which escapes the sense of vision. It is hardly necessary for me to repeat here my references to the observations of Leslie, Hennessey, and others, which revealed variations in the earth's emission for which the observers could not account. A close inspection of the observations of the late Principal Forbes on the Faulhorn, proves, I think, that the action of aqueous vapour came there into play, and his detection of this action, while unacquainted with its cause, is, in my opinion, a cogent proof of the accuracy of his work as a meteorologist.

POSTSCRIPT.

In the *Philosophical Transactions* for 1882, Part I., p. 348, I refer to certain experiments experiments executed by Professor Soret, of Geneva. My friend has recently drawn my attention to a communication made by him to the French Association for the Advancement of Science, in 1872. It gives me great pleasure to cite here the conclusions at which he has arrived.

"The influence of humidity is shown by the whole of the observations; and it may be stated generally, that, other circumstances being equal, the greater the tension of aqueous vapour, the less intense is the radiation.

"In winter, when the air is drier, the radiation is much more intense than in summer, for the same height of the sun above the horizon.

"On several occasions a more intense radiation has been observed in dry than in humid weather, although the atmosphere was incontestably purer and more transparent in the second case than in the first.

"The maximum intensity of radiation, particularly in the summer, corresponds habitually to days exceptionally cold and dry."

Such are the results of experiments executed by a most excellent observer on the radiation of the sun. They apply word for word to terrestrial radiation. They are in complete harmony with the results published by General Strachey in the *Philosophical Magazine* for 1866, while the experimental basis on which they rest was furnished several years earlier.

ON THE

ATOMIC WEIGHT OF MANGANESE.*

By JAMES DEWAR, M.A., Jacksonian Professor, Cambridge, and ALEXANDER SCOTT, M.A.

OUR attention has been directed for some time to a new determination of the atomic weight of manganese. The present communication gives a succinct account of the results of the preliminary stages of such an inquiry; and although the further progress of the investigation may reveal some errors, still we feel convinced the final numbers can in no way differ materially from the memoranda of the present results, and therefore further delay in publication is unnecessary.

The atomic weight of manganese has been determined by many chemists, but the resulting values vary considerably according to the special method selected. These investigators may be divided into two classes—those giving approximately 55 as the number, and those making it about 54. To the former belong Turner, Berzelius, and Dumas, all of whom use the same method, viz., the determination of the silver chloride yielded by a weighed amount of chloride of manganese. Turner also made determination from the analysis of the carbonate, and from the conversion of the monoxide into sulphate; Brandes by analysing the crystallised chloride obtained the number 57. Von Hauer used the same method as that employed by him in the determination of the atomic weight of cadmium, viz., the reduction of manganous sulphate to sulphide by reduction in a current of sulphuretted hydrogen. It is probable that this method is not very trustworthy, as, according to Schneider, the sulphide may be contaminated by oxysulphide. Schneider and Rewack belong to the second class of observers, the former employing the oxalate, and from its analysis calculating the atomic weight by deducting the weight of water and carbon dioxide obtained from the original weight of salt.

Rewack, whose experiments were also conducted in Schneider's laboratory, weighed the water obtained by reducing manganoso-manganic oxide to manganous oxide. One objection to the analysis of the chloride is that it may contain, besides manganous chloride, varying proportions of manganic salts. This is specially the case if, as Forchammer maintains, pure

* A Paper read before the Royal Society, Feb. 15, 1883.

TABLE I.

	Weight of Silver Permanganate.		Weight of Residue Ag+MnO.			
	In air.	In vacuo.	In air.	In vacuo.	Oxygen lost.	Equivalent.
I.	5·8688	5·8696	4·6320	4·63212	1·23748	227·673
II.	5·4981	5·4988	4·3358	4·33591	1·16293	226·965
III.	7·6725	7·6735	6·0538	6·05395	1·61959	227·422
IV.	13·0997	13·10147	10·3179	10·31815	2·78332	225·943
V.	12·5782	12·5799	9·9104	9·91065	2·66925	226·22
			9·9141	9·91435	2·66555	226·53

TABLE II.

No.	$AgMnO_4$.	$AgMnO_4$. Corrected for vacuo.	KBr.	KBr. Corrected for vacuo.	Equivalent of $AgMnO_4$.	Reducing Agent.
1	6·528	6·5289	3·4228	3·42385	227·094	Sulphurous acid.
2	7·5368	7·5378	3·9541	3·9553	226·958	Nitrite of potash.
3	6·1000	6·1008	3·20067	3·20166	226 937	,, ,,
4	5·7457	5·74647	3·00584	3·00677	227·606	Sulphurous acid.
5	6·1651	6·16593	3·23503	3·23602	226·918	Formate of soda.
6	5·1126	5·11329	2·68216	2·6828	226·984	,, ,,
7	5·0737	5·07438	2·6614	2·66204	227·013	Nitrite of potash.
8	13·4466	13·4484	7·05385	7·05602	226·983	,, ,,
9	12·5782	12·5799	6·59861	6·60065	226·972	Hydrogen.
10	12·2686	12·27025	6·4361	6·43808	226·976	Nitrite of potash.

manganous salts are colourless, the pink colour of manganese salts being due to traces of a manganic compound. We have, however, been unable to prepare any chloride or bromide without a pink or rose colour giving a correspondingly coloured solution; and this was also the case even when fused in hydrogen and hydrochloric acid gas. If, however, as Forchammer says, on fusing manganese sulphate with potassium hydrogen sulphate, a white mass is obtained which gives a colourless solution, although containing a large quantity of manganese, then the effect of a trace of manganic salt in the chloride would merely be to lower the equivalent, and consequently the atomic weight. One experiment with chloride and bromide seemed to bear out this idea.

In order to ascertain the values of the atomic weight of manganese which result from careful analysis of the halogen salts, two determinations were made of the molecular weights of chloride and bromide prepared with great care. The number found from the bromide was 214·87, and from the chloride 125·825, yielding the respective atomic weights of manganese of 54·97 and 54·91.

It appeared to us that the analysis of silver permanganate might be employed with advantage, as this salt is found in a very definite state, and can be easily freed from all the allied metals. It, moreover, involved only the atomic weights of silver and oxygen; and as it seemed feasible to calculate the atomic weight of the manganese directly from the loss of oxygen on heating, without the use of any reagent and without the possibility of loss, we expected to get very accurate results. In this we were disappointed, and have not been able to obtain very concordant results by this most direct method, although we still hope to improve them.

Table I. gives the results of the direct determination of the equivalent of the permanganate of silver by reduction in hydrogen.

The silver permanganate was heated in a bulb of hard glass, first in a current of pure air and then in hydrogen, at a red-heat, until it had a constant weight. The residue consisted of silver and protoxide of manganese, and was allowed to cool in hydrogen, which was finally displaced by nitrogen before weighing. From some reason or another we have not been able to arrive at any very concordant results by this method, errors being probably due to impurities in the hydrogen or occlusion of gases in the residue. The method finally employed was to dissolve the permanganate of silver in dilute nitric acid in presence of various reducing agents, such as sulphurous acid, sodium formate, and potassium nitrite. The silver was then determined by adding very nearly an equivalent quantity of pure potassium bromide, and titrating the small amount of silver remaining in solution, by means of very dilute potassium bromide, containing about 1·19 m.grms. of the pure salt per gramme of solution. The solutions were in all cases weighed, thus avoiding errors due to expansion of fluid, faulty graduation of burettes, &c. The titrations were performed in yellow light in an apparatus similar to that used by Stas, and with all the precautions insisted on by him as essential to the accuracy of such determinations.

The permanganate of silver crystallises readily from warm water, and is a very stable salt. It is also quite anhydrous and not in the slightest degree hygroscopic. From its small solubility it is easily freed from adhering impurities by re-crystallisation. The purity of the salt was tested by reducing about 5 grms. by means of alcohol and filtering, when the total residue only weighed 1·9 m.grms. This residue when tested with the spectroscope was found to consist almost entirely of calcium from the distilled water, only the faintest trace of potassium being detected. This sample was only re-crystallised once after precipitation. The salt was usually prepared by the precipitation of silver nitrate by means of an equivalent quantity of potassium permanganate, the solutions being warm, and the silver permanganate was thus obtained in fine needles, which were very easily drained and washed.

A quantity of the salt was also prepared from crystallised barium permanganate which was made from barium chloride and silver permanganate, the barium salt being afterwards decomposed with pure silver sulphate. The method of preparing the permanganate of silver ensures the absence of any trace of silver nitrate, which, as Stas has shown, adheres most persistently to many silver salts obtained by double decomposition. The iodate is an example of this.

Permanganate of silver has several very important advantages over the other bodies previously used for the determination of the atomic weight of manganese. Its freedom from hygroscopic properties and the improbability of its containing excess of any of the elements of which it is composed beyond what is necessary for the formation of the normal compound, recommend it especially for this purpose. Another point which rendered its selection important was to ascertain if a body liable to easy decomposition under certain circumstances could give concordant results in atomic weight, determinations thus putting to a crucial test the amount of variation in the values which may be all related to secondary reactions.

The silver permanganate has advantages over the chloride and bromide of manganese, which are both not only

very hygroscopic, but if fused in hydrochloric acid gas (hydrobromic acid in the case of the bromide) are liable to retain traces of the gas, and this would consequently make the atomic weight too low. All researches on the oxides of manganese have shown that similarity, they are all difficult to obtain in anything like a definite form, with perhaps the exception of the protoxide.

Table II. gives the results of the titration done by the method above described. The use of sulphurous acid as the reducing agent was found unsatisfactory, as a slight residue having the appearance of sulphide was almost always left undissolved. The production of sulphate was also more or less troublesome from its insolubility.

Experiments (6) and (7) were made with a sample obtained indirectly from the barium salt, and were slightly higher owing to the presence of a small trace of barium sulphate easily recognisable by the slight turbidity of the reduced solution. We had hoped by the use of a larger quantity of material than was generally employed, and by the more accurate modes of analysis, to arrive at results comparable in some degree at least with those of Stas; but the preparation of considerable quantities of material of absolute purity frequently involves sources of error not incurred in the preparation of smaller quantities. This we found especially the case in the preparation of our pure potassium bromide, which contained traces of sulphates in every sample. This sulphate is due to the use of ordinary gas in the ignition of the pure bitartrate of potash from which the bromide of potassium was made. In order to get a pure product gas must be replaced by a powerful flame of alcohol, or all the operations conducted in a muffle.

The mean atomic weight of manganese which results from the average of the last eight determinations is 55·038, oxygen being taken as 16 and silver as Stas's value 107·93.

Thus another element is added to the list of those whose atomic weights have been found on revision to be exceedingly near whole numbers.

Further details and discussion must be reserved for another communication.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING JANUARY 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

February 6th, 1883.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the month of January, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 189 samples, all, excepting five which were recorded as "very slightly turbid," were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of a daily sample, taken from January 1st to January 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

The condition of the water during the past month, in respect both to its general freedom from colour and turbidity and to its state of aëration, has continued, notwithstanding the renewal of the river floods, to be eminently satisfactory; while there has not been any appreciable increase in the proportion of its dissolved organic matter. Thus the maximum quantity of organic carbon found in any sample of the water was 0·320 part in 100,000 parts, the average of all the samples examined during the month being 0·217 part, as against an average of 0·210 part in the previous month. The maximum of 0·320 part of organic carbon in 100,000 parts of water corresponds to a little over half-a-grain of organic matter per gallon; and even this amount was present in one exceptional sample only out of the 189 samples reported on.

We have the honour to remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

(Continued from p. 17.)

Separation from Rhodium.—This may be effected by the four following methods:—

1. In a strongly acid hydrochloric solution the gallium is precipitated by potassium ferrocyanide either in the cold or at a moderate heat. All the rhodium remains in solution. To remove it the liquid is mixed with sulphuric acid and sodium bisulphide and evaporated to dryness, raising the temperature finally to redness. Rhodium and iron are then separated by known methods.

2. The action of sulphuretted hydrogen upon rhodium chloride is very slow in the cold and not rapid even at 85°—90° in dilute solutions. At 100° the rhodium chloride is quickly converted into sulphide. The solution should be distinctly acid. If a high degree of exactitude is required the mother-liquors must be concentrated as far as possible without drying them up, expelling the greater part of the hydrochloric acid and repeating the treatment with sulphuretted hydrogen at a boiling heat. In this manner only insignificant traces of the rhodium are lost.

The rhodium sulphide, after filtration and washing with water slightly acidulated with hydrochloric acid, still retains traces of gallium. To remove these it is re-dissolved in aqua regia, the nitric acid being afterwards expelled and re-precipitated by sulphuretted hydrogen at a boil. Along with the sulphide there is deposited sometimes a little metallic rhodium which is not attacked by aqua regia. With care this process gives good results.

3. Copper reduces rhodium, slowly in the cold, but more rapidly at 90°.

It is well to operate upon hydrochloric solutions, slightly acid, and of the smallest volume possible. The water is replaced as it evaporates, and at intervals traces of hydrochloric acid are added. Several hours of heating are necessary. The rhodium thrown down by the copper does not retain gallium, and is partially soluble in aqua-regia.

4. In a distinctly acid hydrochloric solution the rhodium is reduced by zinc on prolonged contact at 90°. A brisk evolution of hydrogen must be kept up by successive additions of zinc and HCl. The reduced metal retains a little gallium, but in a much less proportion than in the cases of palladium or platinum.

Remarks on Certain Reactions of the Salts of Rhodium.—Chemical treatises give, for the qualitative analysis of the salts of rhodium, certain instructions which are incomplete, and to persons not familiar with the rarer metals may prove misleading. Such are:—

"*Ammonium Sulphide.*—A brown precipitate of sulphide which forms slowly, and is insoluble in excess."

"*Sulphuretted Hydrogen.*—A brown partial precipitate, which is formed slowly, and dissolves in hydrochloric acid."

On these instructions I remark that an excess of ammonium hydrosulphate easily re-dissolves the rhodium sulphide, especially at about 40° or 50°; the solution is of an orange-red. If rhodium sulphide is ultimately entirely deposited in presence of the hydrosulphate, it is only after the lapse of a very long time, and from an analytical point of view we may consider this compound as soluble in an excess of ammonium hydrosulphate.

An ammonium hydrosulphate solution of rhodium, after having been left for a fortnight in an imperfectly closed vessel, at temperatures varying from 15° to 70°, was filtered and enclosed in flasks sealed at the lamp. Twenty days later there was found deposited on the sides of the vessel only a quantity of sulphide, relatively very trifling compared with that remaining in solution. The thin pellicle of sulphide attached to the glass was not sensibly soluble in ammonium hydrosulphate.

Rhodium sulphide formed by sulphuretted hydrogen at a boil is likewise insoluble in the hydrosulphate, contrary to what is observed by the sulphide deposited by a boiling ammonium sulphide solution. This latter compound is easily re-dissolved in the hydrosulphate.

The solubility of its sulphide in an excess of ammonium hydrosulphate may serve to separate rhodium from such metals as copper, iron, and zinc, whose sulphides are very slightly dissolved by the hydrosulphate.

If an ammonium hydrosulphate solution of rhodium is treated with a small excess of hydrochloric acid we obtain a reddish-brown sulphide, which dissolves, it is true, in part in strong hydrochloric acid, and even in acetic acid. But in presence of sulphuretted hydrogen there is again formed rhodium sulphide of a much deeper brown, almost black, of which hydrochloric acid dissolves mere traces.

There exist, then, two rhodium sulphides, analytically distinct. The one is of a chocolate-brown, slightly reddish, very soluble in ammonium hydrosulphate, and partially soluble in hydrochloric acid. The other of a blackish-brown, is insoluble in both these reagents.—*Comptes Rendus*, xcvi., p. 152.

SEPARATION OF MAGNESIA FROM LIME, FERRIC OXIDE, AND THE ALKALIES.

By H. HAGER.

IF 1 grm. magnesia is treated with 80 c.c. of a cold 5 per cent solution of oxalic acid a clear solution is obtained, which on boiling deposits all its magnesia as magnesium oxalate. A very small portion of the precipitate is re-dissolved on cooling. If the magnesia is mixed with 10 parts of glycerin before solution in oxalic acid no turbidity occurs on standing in the cold, but the magnesium oxalate is nevertheless precipitated on boiling. For separating calcium from magnesium when both occur as carbonates, the author mixes the finely-powdered sample with 10 parts of glycerin and a little water, and adds 40 to 50 parts of solution of oxalic acid at 5 per cent. Calcium and magnesium oxalates are both formed, the former remaining undissolved, whilst the magnesium salt passes into solution. After standing for half an hour the calcium oxalate is collected upon a filter, washed, and determined as usual. The filtrate is boiled in a flask for five to eight minutes, filtered boiling, and the precipitate is dried and weighed as magnesia.

In a solution containing salts of calcium and magnesium the liquid is first mixed with glycerin, a sufficiency of ammonium oxalate is added, the liquid is strongly acidulated with oxalic acid, and the process completed as above.

Magnesium can also be precipitated as an oxalate in presence of ferric oxide by adding glycerin, ammonium oxalate, and oxalic acid, and boiling. In order to determine the ferric oxide in the filtrate it is heated to a boil along with ammonium carbonate, evaporated to dryness, the glycerin extracted with alcohol, the insoluble residue is treated with hot ammoniacal water, and the ferric hydroxide is collected upon a filter.

For separating magnesia from the alkalies, the hydrochloric solution is boiled with ammonium oxalate and oxalic acid, and filtered at a boil.

The author gives the following method for ascertaining whether in calcined magnesia or in the carbonate the proportion of lime exceeds a certain limit:—0·1 grm. of the calcined magnesia, or 0·25 grm. of the carbonate, must be well shaken up in a test-tube with a solution of oxalic acid at 5 or 10 per cent. Perfectly pure preparations dissolve in the first minute, and the solution remains clear for five minutes: in presence of lime the solution is turbid. In the latter case the agitated turbid liquid is poured into a test-tube of 1·25 c.m. in width, and an ink line upon paper 1 m.m. in breadth is examined through the column of liquid. If this is still possible the proportion of lime in the calcined magnesia does not exceed 0·25 per cent, and that in the carbonate 0·1 per cent.—*Zeitschrift für Analytische Chemie.*

NEW METHOD FOR SEPARATING VANADIC ACID FROM METALS.

By W. HALBERSTADT.

THE method of separating vanadic acid from barium, calcium, zinc, and lead, is based—like Classen's method of separating phosphoric and arsenic acid from metals—upon the circumstance that on heating with ammonium oxalate and acetic acid the metals are precipitated as oxalates, whilst the vanadium remains in solution. The hydrochloric solution is evaporated to dryness in the water-bath, and the residue digested with a saturated solution of ammonium oxalate with the addition of a few drops of strong acetic acid till everything is dissolved. The liquid is poured into a beaker, heated upon a wire gauze, and acetic acid is slowly dropped in from a burette, stirring all the time, as long as a deposit of oxalate is formed. It is digested for some hours at a moderate heat upon the sand-bath, filtered, washed with a mixture of equal volumes of strong acetic acid, water, and alcohol, the filtrate is evaporated to dryness on the water-bath in a tared platinum capsule, the volatile ammoniacal salts driven off by cautious heating, the residual vanadium oxide oxidised to vanadic acid by fusion in a current of oxygen, and weighed.

This method is found successful for separating vanadium from barium, calcium, zinc, and lead, but it is not suitable for a quantitative separation of vanadium from cobalt, nickel, manganese, magnesium, bismuth, copper, and cadmium.

Classen and Von Reis utilise the behaviour of the metallic double oxalates with acetic acid for the separation of arsenic and phosphoric acid from metals.

The great resemblance between vanadic acid and the two acids just named rendered a comparison of their behaviour with oxalic acid and the oxalates desirable.

Vanadic acid when boiled with oxalic acid is reduced to oxide, and takes a blue colour; in potassium, sodium, and ammonium oxalate it dissolves in considerable quantity with a yellow colour, which passes into a blue on the addition of strong acetic acid.

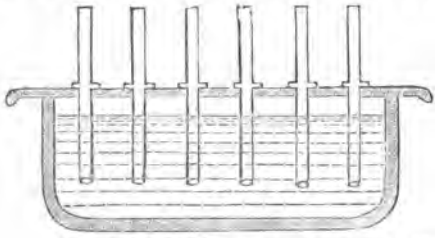
The saturated solution in potassium oxalate, if placed in the desiccator over sulphuric acid, deposits yellowish adherent crystals, which readily dissolve in water, and on exposure to air take a greenish brown colour. On adding alcohol and boiling with potassium oxalate and acetic acid all the vanadium is separated. Phosphoric and arsenic acid, on the contrary, if similarly treated remain in solution in combination with potassium. According to the proportion of the acetic acid and alcohol there is obtained a green or dark-blue deposit of vanadium oxide along with the excess of potassium oxalate. With sodium oxalate the separation of vanadium by alcohol is less complete, and still less so with the ammonium salt. Alkaline meta- and ortho-vanadiates behave with oxalic acid as does vanadic acid.

The vanadium oxide obtained with oxalic acid or ammonium oxalate and concentrated acetic acid, passes again into vanadic acid on evaporation to dryness, expulsion of the ammoniacal salts, and subsequent ignition in a current of oxygen, as the author has proved by direct experiment.—*Zeitschrift fur Analytische Chemie.*

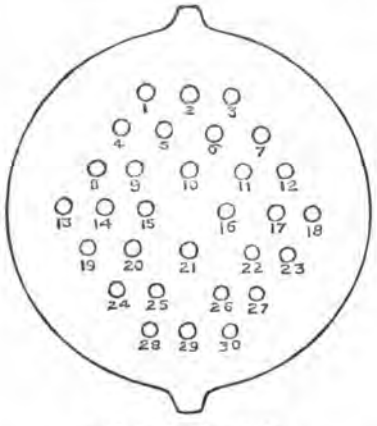
APPARATUS FOR BOILING GOLD ASSAYS.

By W. F. LOWE.

The apparatus consists of (1) a porcelain basin (*a*) 8½ ins. in diameter, having a capacity of 50 ozs.; (2) a porcelain cover (*b*) perforated with thirty holes, each hole being numbered in black enamel; and (3) of a number of glass tubes (*c*). These tubes are made to slip loosely through the holes in the cover, and in order that they may not come against the bottom of the basin the glass is bulged



ction of basin, tubes, and cover, one-fourth size.



(*b*) Cover, one-fourth size.

out into a ring, near the centre of the tube, which rests upon the cover: they have two small holes, one on each side of the bottom, one in the centre of the bottom, and also one in the side an inch above.

The method of employing the apparatus is the following:—Two basins, containing a sufficient quantity respectively of strong and weak nitric acid, are heated over the lamp, the weak acid basin being covered with the perforated cover carrying the boiling tubes, and the strong acid being covered with an ordinary dinner-plate. The assays, which can be flattened and rolled while the acid is being heated, are dipped into the tubes; and in about five minutes, if the acid is boiling, the whole thirty may be lifted off by the cover, washed by being dipped into a basin of water, and then transferred to the basin of strong acid, where they are boiled for half an hour or more, after which they are all lifted off by the cover, and transferred

(*c*) Tube, half size.

to a similar basin full of water. Each tube is taken out, and plunged over head in water so as to fill the tube, and the assay is transferred to the crucible in the same way as from a flask.

I have had this apparatus at work for more than twelve months, and have found it a great saving of labour, besides requiring so little attention; in fact, it can be left for an hour without the assays taking any harm, and I consider it preferable to boiling in flasks, for all the assays are under exactly the same conditions, and can be boiled in the acid for a much longer time. Another recommendation is that it is of very moderate cost. For boiling the basins I use two of Fletcher's radial burners, which are very suitable, as they are little affected by the fumes.

OFFICIAL REPORT OF THE COMMITTEE OF THE INTERNATIONAL SMOKE ABATEMENT EXHIBITION, 1882.*

This interesting report was printed and presented to the Duke of Westminster, as President of the Smoke Abatement Exhibition, in June last, but its publication has from various causes been delayed until now.

In the year 1306 the combustion of bituminous coal in London was prohibited by the King at the petition of Parliament; but the smoke of this fuel still remains so unsubdued a nuisance that after a lapse of exactly five-and-three-quarters centuries the International Smoke Abatement Exhibition was held at South Kensington. By far the larger number of appliances there exhibited consisted of grates and stoves, and their inventors had sought to perfect combustion in them by one of the following methods:—

(1.) The supply of air to the fire was largely increased.

(2.) The fresh fuel was charged in below that already burning.

(3.) The fuel was charged into hoppers situated either

London: Smith, Elder, and Co., 1883.

at the back or sides of the grate, where it became partially coked, the products of distillation entering the fire at some point below its surface, and the partially-coked fuel was afterwards charged in either at the back of or below the fuel already in a state of combustion.

(4.) The fresh fuel was placed on the top of that already burning, and the products of combustion, distillation, &c., were made to pass, more or less completely, through the fire, issuing from it at some point below its surface.

(5.) The products of distillation and combustion, &c., were brought into contact with air more or less highly heated.

The grates relied on one or other of the above systems, but in the case of stoves, only the first and the last two systems were adopted. Some of the grates and stoves were constructed so as to admit of only a limited supply of air to the fire in order to cause the fuel to be more slowly consumed.

It will be seen that the methods adopted with a view to ensure complete combustion were very varied, but in this notice we propose to consider briefly the chemical tests to which the effluent gases from stoves and grates were submitted.

In a report on the gases escaping from the flues to which these stoves and grates were attached, Professor W. Chandler Roberts, of the Royal School of Mines, states that, taking into consideration the circumstances under which the tests had to be conducted, he was led to adopt the following method :—

A hole was bored through the wall of the room to the flue, and through the hole was inserted a copper tube provided with a narrow slit equal in length to the diameter of the flue, across which it was placed; an arrangement was also provided by means of which it was possible to prevent the slit becoming choked. This tube was inserted into the flue at a point 10 feet from the floor; this height being chosen in order to ensure that the samples of gas taken should be of the same average composition as that of the gaseous mixture which passed out of the flue into the atmosphere.

Hung up on the wall, as close as possible to this tube, and in connection with it, were a series of tubes, the first of which was partially filled with asbestos; the second was a U-tube filled with chloride of calcium; then followed three U-tubes filled with soda-lime, each one having a plug of chloride of calcium at the end furthest from the flue to prevent any escape of moisture. The last of these tubes was connected by means of glass tubing with a porcelain one containing cupric oxide, and heated to redness in a combustion-furnace. On the other side of the tube came first a U-tube filled with chloride of calcium; next came two U-tubes filled with soda-lime and chloride of calcium as before: and, lastly, between these tubes and the water aspirator was placed another tube of chloride of calcium.

Directly the fire was lighted aspiration was commenced and continued for a period of three hours, during which time as nearly as possible half a cubic foot of water was run out. The gases on their way to the aspirator were first filtered by the asbestos, which retained all the solid matter, some moisture, and small quantities of gaseous hydrocarbons, &c., enclosed in the sooty matter. The remainder of the water was next absorbed by the chloride of calcium, and the carbonic anhydride by the soda-lime, the free hydrogen, hydrocarbons, and carbonic oxide were burnt by the cupric oxide, the water and carbonic anhydride so formed being absorbed by the calcium chloride and soda-lime respectively. The residual oxygen and nitrogen passed away to the aspirator, but as the ratio in which they stood to one another depended so greatly on the dilution of that air which had passed through the fire, by air which had simply passed up the chimney without passing through the glowing coal, no separate analysis was made of them.

At the termination of the test the tubes were disconnected, and the one containing the asbestos was heated to a temperature of about 200° C., the connection with the tube containing ignited cupric oxide and the tubes beyond being maintained. The first chloride of calcium tube was placed between the asbestos tube and the one containing the cupric oxide, and a current of air free from moisture and carbonic anhydride being aspirated through, the water and some of the solid hydrocarbons were driven forward and retained by the calcium chloride tube, and the gaseous hydrocarbons were burnt by the cupric oxide. It was not possible to heat the asbestos sufficiently to distil off all the solid hydrocarbons, &c., as the point would soon have been reached at which the combustion of the free carbon particles commenced.

By this means the ratio was obtained in which the various gases contained in the sample taken from the flue stood to one another, and in order to make the results obtained from the different grates and stoves comparable, the carbon present as carbonic anhydride was in each case raised to 1000, and the carbon as carburetted hydrogen and carbonic oxide, taken together, were proportionately increased and referred to the 1000 parts of carbon burnt to CO_2. It was found that the carbon as carbonic anhydride stood to that as carburetted hydrogen and carbonic oxide in ratios which varied between the limits of 1000 : 4 and 1000 : 375; but of the whole 86 tests in only three was it above 1000 : 10, and in only nine cases did the ratio rise below 1000 : 200, and of these no less than 6 were purposely worked with a limited (or reduced) supply of air.

In connection with this it may be interesting to point out that the limits 1000 : 10 and 1000 : 211 were those in which M. Scheurer-Kestner (in his celebrated research on the combustion of fuel in boiler-furnaces) found the C as CO_2 to bear to the C as CO and $CxHy$, and these limits do not differ much from those found by Prof. Roberts.

The increase in weight of the asbestos tube did not permit of any direct generalisation being made as to the amount of carbon lost as soot, but the flues were in many instances swept after the test, and the soot so collected was weighed. It was found to vary between the limits of ¼ and 2¼ per cent of the total carbon in the fuel, and two tests made by Prof. Roberts especially to determine the amount of soot so deposited showed it to be in the first case 0·6 per cent, and in the second 0·75 per cent. In the first instance 17 lbs. of coal were burnt in three hours in an open grate, and the soot deposited in a sheet-iron tube 6 feet long and 9 ins. in diameter, was collected and weighed; in the second, 10 cwts. of coal and 59 lbs. of wood were burnt, and the soot, which had been deposited in a flue 60 feet high, was weighed, and gave the above-mentioned result. This would seem to confirm the view frequently expressed recently that the amount of carbon lost as soot does not exceed 1 per cent.

The total carbon in the samples taken stood to the total hydrogen, in a free state and combined with carbon, in ratios varying between the limits of 1000 : 8 and 1000 : 259, which, while higher than those obtained in boiler-furnaces by Scheurer-Kestner, yet agree with some analyses of the gases escaping from locomotives made by M. Foucou; and it is to these latter that the tests on grates made at the Exhibition bear the greatest similarity, as they were always tested directly after having been placed in position, and consequently surrounded by wet mortar, which became almost dry during the test. In order to determine the relation which the carbon present as carbonic oxide stood to that existing in the form of gaseous hydrocarbons, a sample of gas was taken from the flue to which a grate was attached that was purposely stoked very badly; this was collected in a mercurial receiver, and showed on analysis that while very little carbonic oxide was present, yet the carbon as carbonic anhydride bore to that as marsh-gas a ratio (by weight) of 1000 : 529.

The mean of the results from the seventeen best tests of grates shows a loss of carbon as gas of about 3½ per cent of the total carbon in the fuel, both for Wallsend and anthracite, but the mean for the whole of the grates shows a loss of nearly 9 per cent.

The best of the close stoves showed a loss of carbon in gaseous compounds of about 2¼ per cent of the total carbon in the fuel, the mean for the whole class being 6¾ per cent.

Slow and rapid combustion in the same stove, and under similar conditions, showed that of the total carbon in the fuel 11·9 per cent and 1·9 per cent were lost respectively as gaseous compounds.

The combustion in the stoves was found to be about as complete as that in the best class of open grates, which class was decidedly, as far as completeness of combustion went, the one in which the products of distillation, combustion, &c., were made to pass down through the fire, the next best class to this being the one which relied on the admission of larger quantities of air to the fire.

Under-feeding did not seem to be particularly effective in the majority of the grates, but it certainly was in the one exhibited by Messrs. Brown and Green which took the Gold Medal.

The worst class of all was that in which a limited supply of air was admitted to the fire in contradistinction to the one admitting larger quantities, which, as was before stated, was the second best.

The stove exhibited by Mr. C. B. Gregory, of Beverley, New Jersey, which was awarded the highest medal for its class, consisted of a gas-generator with hollow fire-brick sides through which air passed, became heated and met the column of gas on all sides as it passed through a narrow slit. It gave one broad sheet of flame and no smoke. Several applications of this stove—or rather furnace—were shown at Manchester.

The methods by which it was sought to perfect the combustion of fuel in boiler furnaces consisted (1) in charging in the coal at the front of the fire at regular intervals, either directly or on to the bars, or first on to a dead-plate, and in this manner compelling the products of distillation, &c., to pass over the whole of the clear fire beyond. The fuel so charged in was gradually drawn back by the motion of the fire-bars, which either moved in sections or one after the other. (2) In scattering the fuel in small quantities over the whole surface of the grate. (3) By allowing air to enter through the fire-door, a perforated dead-plate, or hollow fire-bridge, &c.

Other methods consisted in forcing in air above the fuel by means of a steam-jet; in increasing the air-supply by using a kind of basket-grate; by causing a better admixture of air with the products of combustion by means of diaphragms, &c.

Almost all of these seemed to conduce either in a greater or a lesser degree to the combustion of the moke.

In the comparative tests of Welsh steam coal and anthracite, with regard to their respective evaporative powers, which were made by Mr. D. Kinnear Clark, M.I.C.E., it was found that the steam coals as a class evaporated per pound of fuel 10·95 lbs. of water from and at 100° C.: the anthracites evaporated but 10·05 lbs., so that the steam coals gave results which were 0·9 per cent better. The best anthracite exhibited possessed about the same evaporative power as the best steam coal, viz., rather under 14·3 lbs. of water per lb. of fuel; but it took far longer to get up steam with the anthracites than it did with steam coal, and the clinker from the former was far more difficult to remove, and the fire-bars were much more attacked, when it was used than when the anthracite type of coal was burnt.

Although the results of the Smoke Abatement Exhibition show that the success yet attained is only partial, still they afford a foundation to build upon, and it would consequently seem as though there could be no doubt but that more vigorous action in the future will be crowned with complete success. It is certain that chemical information of much interest has been gained, and the Report bears abundant evidence of the pains Professor Roberts took to bring the work to a successful issue.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, February 24th, 1883.

Prof. Clifton, President, in the Chair.

New Members:—Prof. A. W. Scott, M.A., Mr. F. G. M. Page, B.Sc.

Mr. Lewis Wright read a paper on the "*Optical Combinations of Crystalline Films*," and illustrated it by experiments. He exhibited the beautiful effects of polarisation of light, and the Newtonian retardation by means of plates built up of thin mica films and Canada balsam. The wedges thus formed gave effects superior to those of the more expensive selenite and calcite crystals. The original use of such plates is due to Mr. Fox, but Mr. Wright showed many interesting varieties of them, including what he termed his "optical chromotrope," formed by superposing a concave and ¼-wave plate on each other. Norenberg's combined mica and selenite plates were also shown.

Mr. Spottiswoode praised the results very highly, and pointed out their value to the teacher and student, as showing how the effects can be produced step by step. The phenomena can be shown by an addition to the ordinary microscope, costing some 2 guineas, as made by Messrs. Swift and Sons.

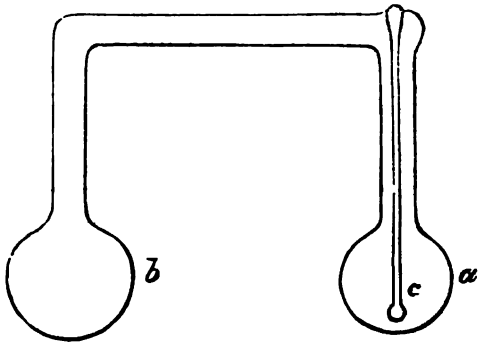
Mr. Braham then gave an experimental demonstration of the vorticle theory of the formation of the solar system by rotating a drop of castor oil and chloroform in water until it threw off other drops as planets.

CORRESPONDENCE.

ICE UNDER LOW PRESSURES.

To the Editor of the Chemical News.

Sir,—The exhibition of the infusibility of ice under low pressures has up to the present time been a somewhat troublesome matter, the amount of time spent in getting the apparatus in order being generally very great. The following method of showing the experiment is simple and works very well, and the apparatus once prepared is



always ready for use. The instrument is an ordinary Wollaston's cryophorus with a glass tube or rod fused into one angle of the glass tube, and terminating in a knob (*c*) rather below the centre of the bulb. The apparatus is exhausted by boiling water in both bulbs until the right amount is left, and then sealing up.

The water is allowed to flow into the bulb (*a*) in which

the rod is fixed, and the other bulb is placed in a freezing-mixture. When the water in (*a*) is frozen to a sufficient depth it is placed for a few moments in warm water, so as to melt the ice in contact with the glass. The water formed is poured quickly into the bulb (*b*), which is at once replaced in the freezing-mixture. By carefully heating the bulb (*a*) the whole of the ice in contact with the bulb may be melted and removed, leaving a free block of ice attached to the knob. The bulb may then be placed in a beaker of boiling water, sulphuric acid, or oil, and so long as (*b*) remains in the freezing-mixture the ice will not melt.

At a meeting of the Owens College Chemical Society, when the apparatus was exhibited, the bulb (*a*) remained in boiling water for about an hour and a half, when the sublimation had proceeded so far that the ice became detached from the knob and fell, and then immediately melted. This is explained by the fact that when the ice comes in actual contact with the hot glass the vapour formed is not removed with sufficient rapidity to keep the pressure below what may be called the critical pressure, and thus the ice melts at once.

By placing thermometers in each bulb the relative temperatures of the ice and of the condenser may be readily ascertained, and Prof. Ramsay and I hope shortly to make some experiments to settle this point; while by a modification of the apparatus, devised by Prof. Ramsay, the latent heat of sublimation of ice may, we hope, be determined.—I am, &c.,

SYDNEY YOUNG.

University College, Bristol,
February 23, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 3, January 15, 1883.

Researches on the Alkaline Sulphites.—M. Berthelot.—The anhydrous potassium bisulphite of Muspratt, Rammelsberg, and Marignac, instead of belonging to the same type as the other sulphites, constitutes a peculiar type, representing a new saline series, the meta-sulphites.

Alkaline Hyposulphites.—M. Berthelot.—The author determines the decomposition-temperatures of the alkaline hyposulphites.

Separation of Gallium.—Lecoq de Boisbaudran.—See page 100.

Hydraulic Silica, and the Part which it plays in the "Setting" of Hydraulic Compounds.—E. Landrin.—Hydraulic silica is the cause of the final hardening of hydraulic mortars. Calcium aluminate, like gypsum, determines in certain cases the setting of the mortar, but it cannot take part in the final hardening of hydraulic materials on account of its solubility. Still, as this solubility is not instantaneous, calcium aluminate, at the moment of immersion, promotes the ultimate union of the hydraulic ingredients, and prevents the water from penetrating into the mass of the mortar, thus facilitating the slow and reciprocal action of the lime and the hydraulic silica.

Chemical Studies on Maize at Different Stages of its Vegetation.—M. H. Leplay.—The author discusses the accumulation of the principal mineral constituents of the soil in different parts of the plants.

Methods for the Determination of the Ohm.—M. Brillouin.—A general exposition of the principles upon which such methods are based.

Reply to a Paper by M. Maurice Lévy.—M. Deprez.—A discussion of the law that the electromotive power evolved by the ring of an induction machine, the intensity of the current being supposed constant, is proportional to the speed of the ring.

Researches on the relative Oxidisability of Cast-iron, Steel, and Wrought-iron.—M. Gruner.—Soft steel is less attacked by acidulated waters, sea-water, &c., than any other of these materials. The action upon tempered steel is ten times greater. Chrome-steel is more energetically attacked than pure steel, but tungsten-steel less so.

Losses and Gains of Arable Soils in Nitrogen.—P. P. Dehérain.—The losses of nitrogen in arable soils are due, not merely to the requirements of the crops, but to a greater extent to the oxidation of the nitrogenous organic matter, these losses being the more considerable the more the soil is turned over. When the land is undisturbed, and kept in natural or artificial meadows, the air penetrates less easily; the combustion is less active, and the gain of nitrogen exceeds the losses. Hence a farmer can enrich his fields with nitrogen more readily by keeping them in pasture than by lavishing manure upon them.

No. 4, January 22, 1883.

Metasulphites.—M. Berthelot.—The author describes potassium metasulphite, the transformation of the dissolved bisulphite into metasulphite, the formation-heat of the latter, its hydrates, their solution-heat, and the pyrogenous decomposition of the metasulphite.

Nitrogen Selenide.—MM. Berthelot and Vieille.—The authors have determined the heat liberated by the explosion of this substance.

Characters of the Induced Currents resulting from the Reciprocal Movements of two Magnetic Bodies Parallel to their Axis.—Th. Du Moncel.—This paper does not admit of useful abridgment.

Theory of the most general Electro-dynamic Actions which may be observed.—P. Le Cordier.—The author's object is to establish the formulæ discovered by Ampère, representing the most general electro-dynamic action which may be observed in a linear element of a fixed current, of constant intensity, and not forming part of the acting system.

Communication by MM. Mercadier and Vaschy relating to the consequences which may be deduced from the relations between Electric Magnitudes.—M. Maurice Levy.—This memoir does not admit of abstraction.

Remarks on the Expression of Electric Magnitudes in the Electro-static and Electro-magnetic Systems, and on the Relations thence deduced.—MM. Mercadier and Vaschy.—The coefficient k' of the formulæ of electro-dynamics is an absolute constant; it is the same with the coefficients of the formulæ of magnetism and electro-magnetism: k' being an absolute constant, the coefficient k of Coulomb's law is the square of a velocity.

Hydraulic Silica.—H. Le Chatelier.—The writer maintains that the results announced by M. Landrin have long been public property, with the exception of the non-hydraulicity of the silica derived from the preparation of hydro-fluosilicic acid.

Mutual Displacements of Bases in Neutral Salts, the Systems remaining Homogeneous.—N. Menschutkin.—This paper will as soon as possible be inserted at length.

Causes capable of affecting the Proportion of Ammonia in Rain-water.—A. Houzeau.—The author has recently received specimens of rain-water from Algeria, in which it was impossible to detect the smallest trace of ammonia. In a former memoir (*Comptes Rendus*, September, 1876) he has shown with what rapidity waters

lose ammonia under the action of solar light. Heat has the same effect as light. Ammonia is also absorbed by the organic matter in water. The greater the quantity of rain which falls the smaller is its proportion of ammonia.

Action of Certain Metals upon Oils.—A. Livache.—The author has studied the action of lead, copper, and tin in a state of fine division upon oils. Lead acts most energetically, effecting a greater increase of weight, in case of the drying oils, in two days than occurs on simple exposure to the air for eight months. Upon the non-drying oils the effect of lead in two days was not appreciable. The action of precipitated lead upon oils may serve as a method of detecting mixtures of the drying and of the non-drying oils. In place of boiling oils, such as linseed—a process which is always attended with an offensive odour and a risk of fire—they may simply be allowed to flow in the cold over plates of zinc or iron upon which metallic lead has been precipitated.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 4, 1882.

Method for the Volumetric Determination of Phosphoric Acid, either Free or Combined with Bases.—O. Schlickum.—Schlickum's method requires either free phosphoric acid or an acid phosphate. Neutral or basic phosphates are made acid by solution in hydrochloric or nitric acid, the liquid is mixed with tincture of cochineal, and normal alkali is added until the colour of the solution changes from yellow to a violet-red. For the titration of the phosphoric acid or of acid phosphates, Schlickum adds a sufficiency of magnesium sulphate and tincture of litmus, and then normal ammonia drop by drop, till the liquid appears permanently blue. The end of the reaction is reached when a drop of ammonia produces no further change. If an excess of ammonia has been added the precipitate is filtered off, and the filtrate titrated back with normal acid. The quantity of phosphoric acid is calculated from the ammonia consumed. If only free phosphoric acid was present the third part of the c.c. of normal ammonia consumed is multipled by 0·071. In case of an acid phosphate half the c.c. of normal ammonia consumed are multiplied by 0·071. If lime is present it must be removed or rendered incapable of reaction before addition of the magnesium sulphate. Schlickum effects this by boiling the liquid containing acid calcium phosphate with sodium sulphate, and allowing the calcium sulphate formed half an hour to settle.

Titration of Free Phosphoric Acid.—A. Joly.—From the *Comptes Rendus*.

Chemical Analysis of Organic Bodies.—(1. Qualitative Detection of Organic Bodies.)

The Spectra of Carbon and its Compounds.

Papers by Wesendonck, Liveing, Watts, &c., are mentioned, but not summarised.

Applications of Spectral Analysis in the Examination of Organic Bodies.—B. Nickels, W. N. Hartley, and A. K. Huntington.—From the Chemical News.

New Reaction for Kreatin and Kreatinin.—J. Weyl.—A very dilute aqueous solution of kreatinin, if mixed with a very dilute solution of sodium nitro-prusside, and then with sodium chloride, drop by drop, takes a fine ruby-red colour, which passes into a straw-yellow. As kreatin is easily converted into kreatinin it may likewise be detected by this reaction. According to E. Salkowski if the straw-yellow liquid is acidulated with acetic acid, it assumes, first a green, and then a permanent blue.

Characteristic Reaction of the Sulph-hydrates.—Peter Claesson.—These compounds are all coloured by the addition of ammonia and a few drops of very dilute ferric chloride. The sulph hydrates of methyl, ethyl, amyl, benzol, toluol, and the thiacetic acid, turn to a dark reddish brown; thioglycolic and thiolactic acids, to a dark violet-red; the sulphocyanides and the hyposulphites deep red; and the hydrosulphates of the alkaline and earthy metals, green.

Detection of Alcohol.—K. Tumsky.—The blue colour produced when alcohol acts upon a solution of molybdic acid in sulphuric acid has been proposed as a test. The author shows that even a moderate quantity of water prevents the reaction.

Reaction of Oil of Peppermint.—C. Roucher.—From the *Druggists' Circular*.

Reactions of Thymol.—MM. Hammarsten and Rolbert.—From *New Remedies*.

Conversion of Starch into Sugar.—F. Musculus and A. Meyer.—The bodies which the authors have formerly described as achroo-dextrine and erythro-dextrine are mere mixtures.

Transformation of Glucose into Dextrine.—F. Musculus and A. Meyer.—When glucose is mixed with sulphuric acid and then with absolute alcohol, a white precipitate is formed on standing, which may be regarded as a dextrine containing 1 mol. alcohol in place of 1 mol. water.

Behaviour of Starch with Glycerin.—Karl Zulkowsky.—Starch dissolves if heated in glycerin, and passes into the modification soluble in water.

Xanthogenic Acid as Precipitant for Alkaloids.—Ph. Zöller.—The alkaloids in all cases when they exist in acid solution or remain in solution when acidulated with very dilute acids, are thrown down as a flocky precipitate on the addition of a few drops of potassium xanthogenate.

The Nitro-prussides of the Alkaloids.—E. Davy.—From the *Pharmaceutical Journal*.

The Alkaloids of Jaborandi Leaves.—E. Harnack and H. Meyer.—From *Liebig's Annalen*.

Piturine.—H. Liversidge.—From the Chemical News.

Coloured Reactions of Morpheine, Codeine, and Atropine.—D. Vitali.—If morphine is dissolved in sulphuric acid (undiluted), sodium arseniate added, and heat applied, there appears a blue-violet colour, which turns pale green, and on the addition of water turns first to a rose, and then to a blue, which on the addition of an excess of ammonia becomes green. Morphine, dissolved in sulphuric acid, mixed with sodium sulphide solution, and heated, gives a flesh colour, which turns to a violet, and then to a dark green. If, after the sodium sulphide, a solution of potassium chlorate in sulphuric acid is added, the colour is first green, then violet, and is turned yellow by excess of chlorate. Codeine gives quite similar reactions. If a solution of potassium chlorate is dropped upon atropine, blue-green streaks appear on moving the capsule. If more of the solution is added, a clear light green liquid is formed.

Picrotoxine.—L. v. Barth and M. Kretschy maintained some time ago that picrotoxine is a mixture of two new bodies, which they named picrotoxine and picrotine. In opposition to this view Paterno and Ogliaro, also E. Schmidt and E. Löwenhardt, maintain the unitary character of the old picrotoxine, and pronounce the bodies discovered by Barth and Kretschy to be products of decomposition.

Cinchonidine, Homo-Cinchonidine and Cinchonine.—H. Skraup has formerly maintained the identity of cinchonidine and homo-cinchonidine. Hesse (*Liebig's Annalen*) upholds their distinct character.

Quantitative Determination of Organic Bodies.—*a.* Ultimate Analysis.

Elementary Analysis of Sparingly Combustible Bodies by Means of Kopfer's Process.—W. Demel.—To prevent the liberation of carbon in the boat the author covers it with three or four times its weight of well-ignited platinum black.

Determination of the Total Nitrogen in Liquids and Solids.—W. Bettel.—From the CHEMICAL NEWS.

Modification of the Varrentrapp-Will Process for Determining Nitrogen.—A. Guyard (Hugo Tamm).—From the CHEMICAL NEWS. J. Ruffle (CHEMICAL NEWS) and R. Kissling (*Chemiker Zeitung*) pronounce Guyard's method impracticable.

Determination of Proximate Constituents.

Quantitative Separation of Fats and Resins.—T. S. Gladding.—From the CHEMICAL NEWS.

Detection and Determination of Hydrocarbons in Fatty Oils.—A. H. Allen.—From the CHEMICAL NEWS.

Determination of Olefines in Petroleum, Shale Oils, &c.—A. H. Allen.—From the *Analyst*.

Quantitative Determination of Pilocarpine.—An account of the methods of Poehl and Christensen.

Determination of Alkaloids as Picrates.—Dr. Hager.—The precipitation is best effected by adding a saturated solution of picric acid to the aqueous solution of the sulphates of the alkaloids. The precipitates are washed with the same saturated solution of picric acid, dried between blotting-paper, washed with petroleum ether, and dried below 40°.

Special Analytical Methods.

Determination of Salt in Sea-Water.—H. Tornoe.—After drying for twenty hours in an air-bath at 170° to 180°, the residue still contains 15 m.grms. water per grm. of salt, whilst so much magnesium chloride had been decomposed that the quantity of magnesia found per grm. was sufficient to neutralise 20 m.grms. hydrochloric gas. To meet this difficulty Tornoe proceeded as follows:—Into a tared porcelain crucible provided with a well-fitting lid, 30 to 40 grms. sea-water were weighed, evaporated in the water-bath, and, after the salts were well dried, the crucible, covered with its lid, was heated for about five minutes over a Bunsen lamp, cooled, and weighed again. The salts were then dissolved in a measured quantity of standard sulphuric acid, and the free magnesia formed by the decomposition of magnesium chloride is determined by titrating back with dilute soda-lye of known strength, using rosolic acid as indicator. From the figures obtained the total saline matter of the sea-water is calculated.

Chemical Examination of Tobacco Smoke.—J. Molnar.—This work is merely mentioned without a notice of its contents.

Determination of Iron in Ores.—L. Pszczolka.—The author makes up the solution of ferric chloride obtained from 1·5 to 2 grms. ore to 250 or 500 c.c.; measures off two portions each of 25 to 50 c.c. into flasks each holding about 150 c.c., boils to expel air, lets cool, and adds cautiously drop by drop sodium carbonate, till the contents of the flasks are of a deep vinous yellow. The solution is then only faintly acid, which is very important for the subsequent titration. After adding from 1 to 1·5 grms. solid potassium iodide, solution of sodium hyposulphite is added from a burette, turning the flask round and round till the colour of the iron solution is of a very faint yellow. About 1 c.c. of a thin boiled starch-paste is added to each flask, and the titration with sodium hyposulphite is continued drop by drop, slowly raising the temperature to from 60° to 70°, until the colour of the solution entirely disappears.

Examination of Asphalt.—D. Claye.—The author dissolves the sample in carbon disulphide, evaporates the filtrate to dryness, and heats till the residue can be ground to a fine powder; 0·1 grm. of this powder is digested for twenty-four hours with 5 c.c. fuming sulphuric acid, then mixed slowly with 10 c.c. water, applying cooling agents, filtered, and diluted with 100 c.c. water. Pure asphalt gives a colourless or pale yellow liquid; in presence of pitch or coal-tar it is dark brown or black. For the detection of tar-pitch in asphalt, H. Hauschild heats the sample to 200°, and shakes it with 5 c.c. alcohol. If only 2 per cent of pitch was present, the liquid has a distinct yellow colour with green fluorescence, which becomes more intense as the colour increases.

Removal of Grease from Iron Filings.—A. Ledebur.—To obtain iron filings and borings free from organic matter and dry, they must be ignited in a current of dry and pure nitrogen gas.

MISCELLANEOUS.

Royal Institution.—Mr. H. Heathcote Statham will give the first of two lectures on "Music as a Form of Artistic Expression," on Saturday, March 10. The subject of Prof. Tyndall's discourse on Friday evening, March 16, is "Thoughts on Radiation, Theoretical and Practical."

Fire Protection.—The premises of Messrs. Kernball, Bishop, and Co., Three Mill Lane, have been furnished with fire hydrants and hose, as well as Brigade hand fire-pumps and buckets, by Messrs. Merryweather and Sons, of Long Acre. Messrs. May and Baker's Chemical Works at Battersea are fitted with similar apparatus, which proved the salvation of their premises on the occasion of a recent outbreak of fire.

MEETINGS FOR THE WEEK.

MONDAY, March 5.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. Cantor Lectures. "Solid and Liquid Illuminating Agents," by Leopold Field.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "Th Conversion of Oleic Acid into Palmitic Acid on the manufacturing scale," by W. Lant Carpenter.
TUESDAY, 6th.—Royal Institution, 3. "The Supreme Discoveries in Astronomy (The Law of Gravitation)," by Professor R. S. Ball.
—— Institution of Civil Engineers, 8.
—— Pathological, 8.30.
WEDNESDAY, 7th.—Society of Arts, 8. "The History of the Pianoforte," by Mr. A. J. Hipkins.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 8th.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
—— London Institution, 7.
—— Royal, 4.30.
—— Society of Arts, 8. "Self-Purification of River Waters," by W. N. Hartley, F.R.S.E.
—— Philosophical Club, 6.30.
FRIDAY, 9th.—Royal Institution, 8. "The Ultra-Violet Spectra of the Elements," Prof. G. D. Liveing, at 9.
—— Astronomical, 8.
—— Quekett Club, 8.
SATURDAY, 10th.—Royal Institution, 3. "Music as a Form of Artistic Expression," by Mr. H. H. Statham.
—— Physical, 3. "On a Method of Measuring Electrical Resistances with a Constant Current," by Sh-lford Bidwell. "On some Uses of a New Projection Lantern," by Mr. W. Lant Carpenter.

THE CHEMICAL NEWS
AND
JOURNAL OF PHYSICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S.

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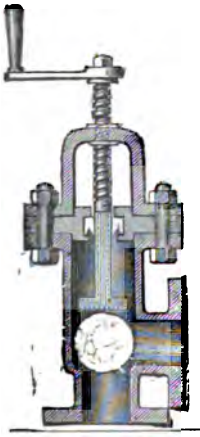

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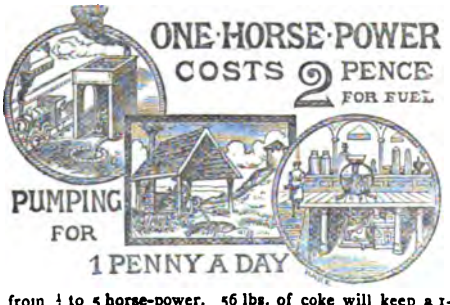

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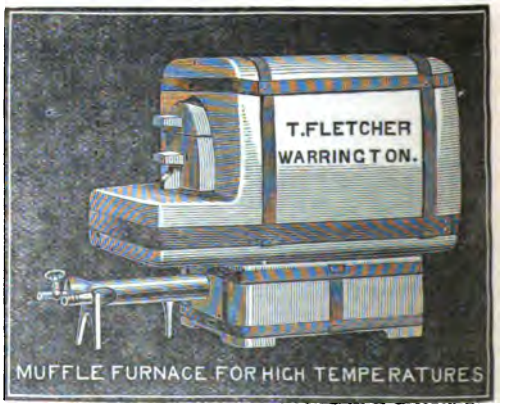

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1215.

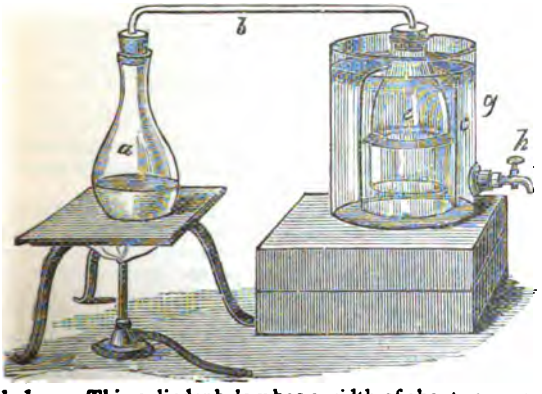
PROCESS FOR THE DETERMINATION OF AMMONIA BY DISTILLATION.

By Dr. O. KNUBLAUCH.

Methods for the determination of ammonia must, along with the greatest possible accuracy, be capable of rapid execution, and permit the use of easily managed apparatus. Though the method I have hitherto followed left nothing to be desired in the way of accuracy, it did not fulfil the two other conditions in such a degree as the frequent recurrence of these determinations rendered desirable.

I have succeeded in overcoming these defects, so that a distillation may be completed in twelve to fifteen minutes with the apparatus to be described, so as to yield strikingly concordant results.

The apparatus will be readily understood from the accompanying figure. *a* is the distillation flask, holding about 200 to 250 c.c. It is connected by means of a tube, *b*, bent twice at right angles with the absorption-vessel, *c*: *c* differs essentially from the ordinary kind of absorption-vessels. The tube is secured by means of a caoutchouc stopper at *d* in the cylinder *e*, which narrows above and is open



below. This cylinder below has a width of about 40 m.m., and is bent outwards at its margin in several places like the lip of a beaker. The escaping gas bubbles are thus better divided. Above there is fixed round the neck of *e* a cork disc at *d* (movable with a wedge), through which the cylinder lies against the outer vessel *c* in such a manner that *e* reaches to some millimetres from the bottom. This entire absorption apparatus is set in an outer vessel *g*, which is filled with cold water for cooling. The water can be run off as often as is desired by the cock *h*, and cold water run in its stead.

The following example of the determination of the ammonia in a sample of crude ammonium sulphate is added. 20 grms. of the salt were dissolved in 500 c.c. of water; of this liquid 25 c.c., corresponding to 1 grm. of the salt, are introduced into the flask *a*, and its sides are rinsed down with about 10 c.c. of water. The absorption-vessel is charged with normal sulphuric acid, taking a few c.c. more than necessary to neutralise the ammonia given off from 1 grm. As ammonium sulphate contains more than 24 per cent of ammonia, more than $\frac{24}{0{\cdot}017.\ 100}$ = more than 14·12 c.c. of acid must be used. After adding a few drops of rosolic acid, and so much water that the internal cylinder may dip about 1 c.m. into the dilute acid, the absorber is placed in the cooler, and connected with the flask by the tube *b*, a piece of potassium hydroxide being placed at the same time in the flask. I wrap the potassa in a piece of filter-paper, having observed that the liquid then boils much more quietly, as the paper floats upon the surface and breaks up the steam-bubbles. It is convenient to add a little solution of rosolic acid to the flask *a*: after the distillation is at an end the contents of *a* must still have an alkaline reaction, a proof that a sufficiency of potassa has been added. Instead of solid potassa normal alkali of known strength may be used, always in sufficient excess. The apparatus is set so that *b* slopes upwards slightly towards *c*. In distilling a tolerably strong heat may be applied at the beginning. The air escapes first in large bubbles; then the liquid merely rises and falls, bubbles seldom escaping, and the surface absorbs almost all the ammonia without much agitation. If the bulk of the distillate increases too much, then to reduce the pressure the inner cylinder may be raised a little, and secured by means of the little wedge. After from one-half to one-third of the liquid in *a* has distilled over the flame is extinguished, the tube *b* is disconnected, and when sufficiently cold the residual acid is titrated in the absorbing vessel itself. No part of the apparatus requires rinsing. —*Zeitschrift für Analytische Chemie.*, vol. xxi., p. 161.

REACTIONS FOR THE RECOGNITION OF THE RESORCINE COLOURS.

By R. BENEDIKT.

The commercial eosines may be readily distinguished from each other by their behaviour with zinc-powder and ammonia and with boiling potassa. The experiments with zinc-powder and ammonia are most conveniently conducted as follows:—Some drops of a moderately concentrated solution of the dye are diluted with water in a test-tube, a few drops of ammonia and some zinc-dust are added, and shaken up. All the eosines are entirely decolourised, even in the cold. The colourless liquid, filtered from the excess of zinc, is for the most part oxidised slowly on exposure to the air, but the colour returns quickly on boiling, till a copious deposit of zinc hydroxide is formed, adding hydrochloric acid to dissolve this precipitate, and again supersaturating with ammonia. The potassa employed for testing should have the specific gravity 1·30. It occasions precipitates in the concentrated solutions of some colouring matters, and on boiling it occasions characteristic changes of colour.

The same reactions serve as a key for the discovery of eosines when fixed upon cloth. A few square centimetres of the dyed tissues are stripped with hot water, to which a few drops of ammonia or potassa have been added, and the liquid, poured off from the cloth, is tested in the same manner as the solution of a dye. Eosines soluble in alcohol are but very slightly stripped by water, but readily by means of alcohol. Those soluble in water are not touched by alcohol.

The following resorcine colours have been examined:—

- Eosine G (tetra-brom-fluoresceine potassium).
- Eosine B (tetra-iod-fluoresceine sodium).
- Eosine B N, safrosine (brom-nitro-fluoresceine sodium).
- Erythrine (potassium salt of mono-ethyl-tetra-brom-fluoresceine).
- Phloxine (tetra-brom-dichlor-fluoresceine potassium).
- Rose bengale (tetra-iod-dichlor-fluoresceine sodium).
- Cyanosine (potassium salt of mono-methyl-tetra-brom-dichlor-fluoresceine).
- Chrysoline (benzyl-fluoresceine sodium).
- Phloxine, rose bengale, and cyanosine are derivatives of a dichlor-fluoresceine which is produced with dichlor-phthalic acid.

The sample of dye under examination is digested with zinc-powder and ammonia and filtered.

(1.) The filtrate quickly takes a crimson colour without fluorescence. A fresh portion, boiled with potassa, becomes at first more fluorescent, then turns olive without fluorescence, and on dilution with water becomes greenish without fluorescence. The original solution has a green fluorescence: Eosine B N (safrosine).

If the filtrate becomes coloured very slowly, boil till the white precipitate is formed, and add hydrochloric acid and ammonia. The liquid is coloured and fluorescent. Examine further as in (2).

(2.) The liquid by transmitted light has the same, or nearly the same, colour as the original solution when equally diluted. See (3).

The liquid is slightly reddish yellow with decided yellowish green fluorescence, whilst the original solution is crimson without fluorescence. See (5).

(3.) Liquid and original solution both yellow, with decided yellowish green fluorescence. No change on boiling with potassa: Chrysoline. The liquid and original solution crimson if sufficiently diluted; the liquid with a yellowish green fluorescence; the original solution with orange; yellow or yellowish green fluorescence: any of the bromiferous eosines. See (4).

(4.) *a.* Potassa causes no precipitate, but on heating turns violet with green fluorescence, and *before* the temperature reaches a boil, blue with green fluorescence. On dilution with water, likewise blue with green fluorescence. The dye soluble in water, and not stripped from the fibre by alcohol: Eosine G.

b. Concentrated potassa precipitates most of the colour; the liquid is opaque, but fluoresces strongly orange. On boiling the same changes ensue as with eosine G, but far more slowly, so that the liquid must boil for some time before the blue appears. The colour dissolves with great difficulty in cold water; soluble in dilute alcohol with very strong yellow fluorescence. Water strips the dyed cloth slightly; alcohol abundantly: Erythrine.

c. Potassa gives a purple-red turbidity in the cold; on heating the liquid becomes first violet with yellowish green fluorescence; on boiling blue, *without* fluorescence; similarly on dilution with water. The dye is soluble in water, and is stripped from the fibre by water, but not by alcohol: Phloxine.

d. Potassa effects an almost complete precipitation; the liquid fluoresces less strongly than in the case of ethyl-eosine. On boiling the change of colour does not go beyond a violet-blue, and the liquid looks dull unless it contains very little colour. On dilution with water, violet with yellow fluorescence, which becomes stronger on the addition of alcohol, and the liquid turns to a redder shade. The dye dissolves in alcohol with very strong orange-yellow fluorescence: Cyanosine.

5. Potassa gives a slight turbidity. On boiling the liquid becomes first purple, then violet, and blue with green fluorescence, lastly brown. On dilution with water very slightly coloured, with strong fluorescence. The dye is soluble in water: Eosine B.

Potassa gives a slight turbidity. The liquid on boiling, blue without fluorescence (on dilution purple-violet); on further boiling dirty-violet (on dilution purple with slight fluorescence): Rose Bengale.—*Chemiker Zeitung*: *Coethen.*

Sophistication of Quinine Sulphate.—The quinine sulphate supplied to the hospitals of Paris has been found curiously deceptive. At the top and at the bottom of the box was a stratum of the salt required, of good quality, but the intervening space was filled up with cinchonine sulphate. The French firm who supplied the drug profess ignorance of the fraud, and assert that the boxes were supplied to them ready filled by a house at Milan, which has been recently amalgamated with a German manufactory. The matter is said to have occasioned some diplomatic ink-shed.—*Les Mondes.*

REPORT ON GAS BURNERS.*

By THOMAS FAIRLEY, F.R.S.E.,
Public Analyst and Gas Examiner.

THESE tests have been made with gas averaging about 17·5 candles,† and corrected for variations in temperature and pressure which affect the measurement of the gas.

The certified Methven unit has been employed, checked by frequent comparison with the best standard candles. The Methven unit is more constant than any candles, and gives the best standard for burner tests known at the present time.

The burners tested are of four kinds, each with modifications by different makers. The "union jet" or "fish tail"; the "batswing"; the "slit union" or "flat flame"; and the "Argand." These are each made with or without a check at the bottom of the burner to diminish the pressure, or with or without a small governor attached to each burner to keep the consumption constant.

The Siemens regenerative burner is somewhat different from any of these, but is a modified Argand with fittings for heating the gas and air by the waste heat of the flame. This principle was first applied, many years ago, by Leslie and by Faraday, and gives an increase of from 30 to 60 per cent in the light obtained.

As a rule, burners with governors are preferable to burners without them, even where a governor is attached to the meter. Any burner with too little gas is flickering and unsteady, and often smoky, and with too much gas it is also wasteful and generally smoky. Each burner has a particular pressure at which it gives its best results.

The burners most sensitive to variations of pressure are the union jets and the Argands. These are much improved by a check or governor attached to the burner. Where a very steady uniform localised light is desired, and a burner not very sensitive to the effects of dust, the union jet may be employed, but it gives less light for the gas consumed than the other burners, especially with the smaller sizes.

The slit burners are more sensitive to dust, but the proportion of light obtained per foot of gas equals or surpasses in some instances that obtained from the Argands.

The Argands require more care and attention than any other form. Unless reflectors are used, the light is given off chiefly in the horizontal plane of the flame so much that it is much darker above or below the burner. The chimney glasses require daily cleaning.

An Argand is more smoky than any other burner if too much gas is supplied to it, and gives exceedingly little light when the supply is too small.

Some makers send out duplex burners (two small burners mounted so that the flames coalesce). These burners are smoky at low pressures, giving a flame of the same character as that from a large-sized ordinary burner with too small a supply of gas. At higher pressures, 1·5 ins. and upwards, they give better results, but not superior, or often so good, as those obtained from the best single burners.

To meet the requirements of consumers who wish to get the best results at a given consumption, I have attempted to classify the results, naming the burners which give the maximum light at each consumption, without undue smoking.

None of the batswing burners are suitable for globes, while the union jets and slit unions or flat flames are suitable. No globes should have an opening, at the bottom, of less than three inches, otherwise a great part of the light is lost. Mica or porcelain tops placed over the globes help to increase the light and to diminish the production of smoke.

* Presented to the Gas Committee of the Council of the Borough of Leeds, November 16, 1882.

† When tested by the 15-hole Argand burner according to the conditions of the Leeds Gas Act.

For consumers wishing to consume gas at a given rate in each burner, I beg to point out the results obtained from—

2 to 3 Feet per Hour.

	Retailed at
Bray's No. 1, plain and special slit unions,	1d. and 3d.
Sugg's "Winsor" check burner, No. 3	1/0
Borradaile's governor burner, 2 feet	2/6
Brönner's 4 A-top	1/6

3 to 4 Feet per Hour.

Bray's Nos. 1 and 2 special slit unions and special batswings	3d.
Bray's No. 2, union jet (special)	3d.
Sugg's Christiana governor burner, No. 3 ..	3/6 to 5/6*
Peebles' governor burner, No. 3	1/6*

4 to 6 Feet per Hour.

Bray's No. 3 special slit union; Nos. 3 and 4 special batswings	3d.
Sugg's Christiana, No. 5	3/6 to 5/6*
Sugg's check burners Nos. 4 and 5	1/0
Sugg's London Argands	5/6 to 8/0
Borradaile's 5 feet governor	2/6
Peebles' Nos. 4, 5, and 6	1/6

6 to 10 Feet per Hour.

Bray's slit unions and batswings, Nos. 4, 5, 6, 7, 8, and 9, plain and special	1d. and 3d.
Bray's union jets (special), 4, 5, 6, 7, 8, and 9 ..	3d.
Brönner's No. 5 B top	1/6
Silber's duplex batswings, at high pressures only ..	1/6
Peebles' governors, Nos, 6, 7, and 8	1/6
Sugg's Christiana, No. 6	3/6 to 5/6
Siemens's flat flame burner	£4

Above 10 Feet per Hour, for Street Lighting, &c.

Bray's large burners	
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* Without globes.

THE TECHNICAL ASPECTS OF LIGNIFCATION.*

By C. F. CROSS.

THE subject upon which I have undertaken to address the Society is one of fundamental importancee, whether regarded from the technical or the more purely scientific side. The latter involves the consideration of the plant as the great synthetical laboratory of the natural world, and of cellulose and lignose as the most extensive products of this synthetical activity; on the other hand, cellulose and its lignified derivatives constitute the raw material for what are amongst the most important trades of a civilised community, viz., the manufacture of paper and textile fabrics from vegetable fibrous materials. While, in dealing with this subject, it will be necessary to confine ourselves as closely as possible within the limits expressed by the title, the object contemplated in its selection cannot be compassed with exclusion of theoretical considerations; for it is necessary to show that the methods in general use for the treatment of cellulose substances involve a general principle; and that this principle is the reverse of that which is based rather upon a knowledge of their chemical constitution than upon an empirical obvervation of certain changes wrought upon them by reagents, and is, therefore, the foundation of a more rational treatment.

In order to elucidate this central antithesis, it will be necessary to trace, briefly, the development of our present system of cellulose technology. As our chemistry is by nature what we may term a water and oxygen chemistry, so we find that our chemical processes of treating vegetable fibres, for the purpose of adapting them to their finest uses, having been evolved from observation of the action upon them of substances and under conditions the most readily available, are dominated by water and oxygen. In this process of evolution, we mark the following stages:—(1.) The observation of the natural isolation of fibres by the process of dew-retting. The greater number of vegetable fibres used in the arts are obtained from compound structures of which they are constituents. First in order of biological simplicity stands the large group of bast fibres, usually of great length, and, as they occur, ordered into a more or less compact tissue, lying beneath the bark. Next we have the fibrovascular bundles of monocotyledonous plants which are scattered throughout the cellular matrix of the stems and leaves; and lastly, the biological complex, wood. The fibres of the two first divisions are alone available for textile purposes, and their isolation from the cellular matter with which they are associated, is frequently seen to be accomplished by the natural or unaided process of retting. The ingenuity of man is not slow, even its earliest phases of development, to take advantage of the materials thus brought to hand, and then to aid nature in bringing these structures in contact with water, under regulated conditions, so as to secure the most advantageous results. The fibrous character of wood is also revealed by the process of dew-retting, and the product, though unavailable for human use, is not lost sight of by the hornet and other insects who employ it in making their nests.

In the next stage, we may include the manipulation of the isolated fibres into articles of clothing and domestic use, the washing of these in cold water, and, as the result of growing observation, in hot water, with the addition of wood ashes. The prosecution of these processes involves experience of their softening action, together with the bleaching effects of exposure to air and light in the process of drying. An extension of these rudimentary methods will be seen to include our modern processes of scouring cellulose fabrics.

The employment of fibres, isolated from wood, plays no part in the general process of the evolution of this special knowledge, and we must therefore defer its consideration in passing on to the third stage of progress.

The application of chlorine, and subsequently chlorine compounds—the hypochlorites of the several bases—to the bleaching of cellulose substances, completes the chain of development of the natural or oxidation method, which is now firmly and universally established.

It has long been held that the action of these hypochlorites upon the colouring and other adventitious matters which they remove is one of oxidation, and a confirmation of this, if indeed confirmation were needed, is to be found in the recent application of the permanganates to the same end. The practical value of their application, which is well established in respect of simplicity and certainty, will increase with the increasing cheapness of this source of oxygen. To us it is interesting, as completing the demonstration of the foundation of our present system of scouring and bleaching cellulose fabrics uniformly, upon methods which involve the oxidation of their constituents. These processes, which have so long occupied a position regarded as unassailable, have recently come under suspicion, and in their empirical extension to substances other than, and yet similar chemically to, those with which they yielded results of general excellence, have led to observations which suggest the necessity of a revision.

First, in the application of calcium hypochlorite to the bleaching of jute, it was found that, under certain circumstances, chlorine compounds of the fibre constituents were formed. This difficulty, however, was easily overcome by substituting soda for lime; but a second difficulty yet remained in the experience that jute fabrics, bleached by means of the soda compounds, underwent further changes when exposed in the dry state to the atmosphere, and that

* A Paper read before the Society of Arts, January 25, 1883.

when such fabrics were steamed, as in the calico printing processes, these changes were intensified, and made evident by considerable discolouration, and often by disintegration; the latter effect requiring, in many cases, a subsequent exposure to the atmosphere of varying duration, for its more complete manifestation. The cause of these phenomena was found to lie in certain constituents of the fibre substance, which have the property of absorbing oxygen to form acids; and an effective remedy was discovered in impregnating the fabrics with alkaline sulphites, the reducing action of which arrested the tendency impressed upon the fibre substances by the oxidising value of the bleaching processes, and the presence of which was found to counteract the disintegrating effects of long exposure and of the action of steam, previously experienced. We must content ourselves with a passing notice of this point, which will be found fully treated elsewhere, in order to give greater prominence to the discussion of the second count in the indictment of the oxidation method of treating vegetable substances for the isolation of cellulose. This is afforded by the history of the process of treating wood for the preparation of paper pulp. These processes have recently advanced to a position of considerable importance, and the experience upon which they have been developed is not only of great interest technically, but throws light upon a number of the recondite problems of plant chemistry. It will be seen, as we proceed, that this experience has been closely similar to that which was worked out in the case of jute; a fact which is to be regarded not merely as a coincidence, but as the necessary consequence of the close similarity in chemical composition of the substances in question; and the occurrence of similar difficulties, leading to the adoption of similar remedies, as a result, moreover, of altogether independent investigations, will contribute very much to the recognition of the necessity of revising our cellulose technology, upon the principles which they go to establish.

To elucidate these more clearly, it will be necessary to give a brief survey of the chemistry of the compound celluloses from a theoretical point of view, which has been arrived at through a variety of contributory agencies:—(1) the conclusions of physiologists with regard to the chemistry of the development of cellulose and its derivatives; (2) the verification by chemical research of these conclusions; and (3) an independent study of cellulose and lignose as isolated individuals.

Cellulose, in the form of bleached cotton, is a well-defined body, the properties and characteristics of which are too familiar to need recapitulation. Bleached linen, on a general presumption of the identity of the celluloses, has been regarded as identical with cotton. The treatment of these fibres, on the other hand, proceeds upon the recognition of considerable differences between them; and while these have not yet found definite chemical expression, they are sufficiently evident to point to the individuality of the members of the group of celluloses. This, we hold, constitutes the only satisfactory basis of their technology. Biologists necessarily ignore these differences, and understand by cellulose a substance having those properties which chemists regard only as typically characteristic; these are chiefly external appearances, and the blue colouration which it gives with Schulze's solution. Such a substance appears to constitute the original form of all plant fibres, as indeed of the skeleton generally; and although varying with the condition of its elaboration and hydration, these variations may be regarded as comparatively unessential. The phenomenon of lignification is superinduced upon this cellulose basis, and, according to recent views, through a process of intrinsic modification. A very simple type of this process, if not the simplest, is to be found in the jute fibre, the chemistry of which, as already indicated, involves to a large extent the chemistry of wood. A recapitulation of its chief properties, parallel with those of cellulose (cotton), will give a concise view of the more conspicuous chemical changes involved in lignification:—

	Cellulose (cotton).	Lignose (jute).
1. Carbon-percentage	44	47
2. Action of chlorine (moist)	Oxidises	Oxidises and chlorinates.
3. Action of dil. acids at 70°	Forms hydrocellulose.	Resolves into soluble modification and ultimately furfural, &c.
4. Action of nitric acid ($HNO_3+H_2SO_4$)	Forms colourless explosive compounds	Forms yellow coloured explosive compounds.
5. Reaction with aniline sulphate	Nil.	Yellow colour.
6. Reaction with Schulze's solution	Blue colour.	Brown colour.

These are the main features of the evidence which goes to show that in the process of lignification the typical characteristics of the original cellulose are maintained; and, moreover, that lignified fibres are not composed of cellulose mixed merely with adventitious or encrusting substances which mask its ordinary reactions, but that they are made up of cellulose, or a cellulose "residue," in a state of intimate chemical union with molecules, which confer upon them their special features of difference. Of these we may select, as having a more direct bearing upon our subject: (1) the formation of the peculiar aldehyd, known as furfural, under digestion with dilute mineral acids at 60° to 80° C.; and (2) the formation under the action of moist chlorine of chlorine-substitution derivatives, which appear to have close connections with the trihydric phenols. On the latter of these we need say but a few words. Although phenol derivatives are formed from the jute fibre substance, the evidence goes to show that it contains actually no aromatic constituents, no derivatives of such having been obtained by any process of modification other than that of chlorination—or, at least, only in insignificant quantity. Woods, on the other hand, do contain aromatic substances, many in large proportions; of these we may mention many colouring matters, astringents, and glucosides.

The former property, of yielding furfural, and under such conditions as cannot involve any radical chemical change, leads to the very important conclusion that processes for the treatment of lignified fibres, which in any way involve chemical modification, should have strict reference to the aldehyd character of the substances of which these are built up, or, to express it more correctly, to the fact that the immediate products of the hydrolytic resolution of the lignified celluloses are aldehyds of the furfural type.

The aldehyds, as is well known, represent the intermediate stage of oxidation of an alcohol to its corresponding acid. This essential incompleteness is the cause of their characteristic properties, viz, (1) the avidity with which they combine with oxygen to form acids; (2) tendency of union of like molecules to form polymeric modifications; (3) tendency to synthetical union with other molecules to form complex derivatives, which are frequently coloured and generally resinous in character; (4) tendency to cumulative resolution, or condensation with elimination of the elements of water. These properties confer upon the aldehyds a condition of "chemical tension," which, as has been recently theorised, plays an important part in the synthesis of proteid substances in the living organism; and an extension of this conception of the chemistry of life may reasonably be anticipated in regard to the substances we are considering, and, therefore, to the whole work of building up vegetable structures. We must, however, refrain from a somewhat speculative discussion, and turn to the practical applications of our observations.

The treatment of jute in the manner already described, follows as a simple deduction. The presence of sulphurous

acid antagonises the oxidising action of the conditions to which the fibre is subjected, exposure to which is otherwise extremely prejudicial, inducing decomposition in the manner already described.

Of much greater practical importance, however, are the processes for treating wood and other resistant vegetable substances for the preparation of paper pulp, and the modifications of these, which we can show to follow from what is known of the composition of these fibrous structures. Up to within a comparatively recent period, these processes have consisted uniformly in a drastic treatment with alkaline solutions; the process of boiling under pressure with caustic soda, originally applied by Routledge to esparto, has been generally extended and adopted, and is, indeed, the standard method of treating lignified substances for paper-making; efforts to substitute this process by one based upon the principle of reduction or anti-oxidation have been made by one or two technologists, who at the same time, do not appear to have approached the subject from the same point of view. The subject appears to me to have been developed most consistently by Fry and Ekman, and as their labours have had strict reference to the principles under discussion, their treatment will occupy the prior place.

Fry commenced the investigation of this subject about 17 years ago. He was familiar with Houghton's process, the object of which was to throw the work of disintegrating the wood upon the agencies other than the alkali, which latter it was found could be proportionately reduced in quantity. Fry was led to investigate the resolving action of the water alone, under the guidance, not unworthy of mention, of a passage in Faraday's "Manipulation," which directs the chemist, in analysing a mixture, to adhere to the method of preliminary separation by means of solvents successively applied, of these water being the first. It was found that water, at a sufficiently high temperature and pressure (70 lbs. of steam), exerted a very considerable disintegrating action, sufficiently indeed to produce a pulp well-adapted to the manufacture of brown paper; also that of the soluble products of resolution a large proportion were acid bodies. The following statistics, having reference to the two processes, are worth reproduction, the wood operated upon being in both cases that of the common *Pinus sylvestris*:—

(1). *Houghton Process.*—5378 parts (dry) wood, yielded 1787 parts dry pulp = 33 per cent.

(2). *Water Process.*—6338 parts (dry) wood, yielded 4424 parts dry pulp = 70 per cent.

To neutralise the solution from the boiling (2), 1000 parts $Na_2CO_3 10H_2O = 216{\cdot}8$ parts Na_2O were required. The acids formed in such large quantities were partly volatile, *i.e.*, of low molecular weight, and derived from the substituting or side groups in the original molecule of the wood substance, and partly acids of high molecular weight, exhibiting derivation rather from the central nuclear carbohydrate group.

These acids are formed by the hydrolytic resolution of the wood substance, accompanied by oxidation at the expense of atmospheric oxygen, or it may be also of oxygen derived from other portions of the wood substance itself. It is also evident that the acids, when formed, must react on further portions of the wood substance, and aid in its resolution and disintegration.

A number of the by-products obtained in this process were also investigated. It has already been stated that the chemical constitution of wood is, in the main, identical with that of jute; this identity we may express more precisely as limited to the ground substance of the wood; and the decomposition of this by the action of the superheated water, gives rise to some quantity of furfural and other aldehyds, which were collected, in Fry's experiment, by means of an elaborate condensing arrangement. These aldehyds were accompanied by a number of other volatile products, boiling below 100° C., which have not yet been fully investigated. These are derived partly from the ground substance, and partly from the resinous and other characteristic constituents of the wood, which may be considered as distinct from the ground substance, With regard to the aromatic substances, in the presence of which the woods show a further distinction from the bast fibres, these were so far complicated by combination with the aldehyds which are formed during the process, as to be in a condition altogether unfit for investigation.

As regards the resolution of their ground substance, or lignose, as it is termed, the woods resemble very closely the jute fibre, and those substances which are allied to it. A comparison of these fibres with one another, in relation to the action of superheated steam upon them, and the percentage of their substance thereby converted into soluble products, has been made by Dr. Forbes Watson, with the results contained in the table.

The interesting point to be noticed is that the loss per cent follows the order of the fibres, in respect of lignification. Although these investigations were not extended to woods, it is known from other sources that their behaviour affords an additional proof of this statement.

The process of disintegrating the wood by means of water, at elevated temperatures, was worked to a practical issue, and a mill was put up at Bergvik, in Sweden, for the manufacture of "half-stuff" for brown paper. At the same time, investigations were continuously prosecuted with the view to increase the solvent action of the water, and thus to arrive at a product more nearly approaching cellulose. It became more and more evident that the condition of oxidation was especially inimical to this end, and to antagonise it by the presence of a reducing agent was the purpose which underlay the next series of experiments. These were carried out by Ekman, and his choice of a reducing agent soon fell upon sulphurous acid, a choice, which was perhaps, in the first instance, determined by a natural fitness on the side of economy, but is now seen to have the more important function conditioned by the peculiar relationship of the sulphites to the aldehyd products of resolution of lignose. The results which followed from this modification, the removal of a further 20 per cent of the non-cellulose constituents of the wood, and the production of a residue which is but little removed from pure cellulose, are now matters of common knowledge. The special commercial advantages which this process offers, viz., the power to employ a raw material at £2 to £3 per ton, from which 40 to 50 per cent of a pulp is obtainable, suitable for all classes of paper; the use of reagents of little cost; and the production of a solution of the non-cellulose constituents, from which, doubtless, valuable products are to be isolated, or which, at least, will cause no detriment to the water-courses into which it may be run, are sufficiently obvious to have already commanded considerable attention from practical men.

The Ekman process differs from the water process, in the sole particular of the presence of the magnesium sulphite; and the function of this salt appears to be, not so much to aid positively in the resolution of the wood, as to prevent the degradation of its constituents in virtue of the reducing activity of its sulphurous acid, and the property of the entire salt of forming compounds with certain of the non-cellulose constituents which enter into solution. In other words, the water, at the elevated temperature at which it is employed, appears to be the effective solvent; but while, under ordinary circumstances, this solvent action reaches a limit determined by the formation (by way of oxidation and synthetical combination) of secondary derivatives, which resist the solution, these secondary changes are obviated by the presence of the sulphite, and the resolving action of the water is allowed to proceed unimpeded.

Other processes for resolving wood by means of solutions of sulphites have been patented, and worked with more or less success. Upon the exclusively practical question of deciding as to the relative merits of these, it is not for us to speak. We may, however, inquire from what point of view their originators have investigated the matter, and therefore, so far as a study of their specifica-

TABLE SHOWING THE COMPARATIVE RESISTING POWER OF VARIOUS INDIAN AND SOME OTHER FIBRES UNDER THE ACTION OF HIGH-PRESSURE STEAM AND BOILING WATER.

(Fibres arranged in order of effect produced, commencing with those least influenced).

Experiment No. I.			Experiment No. II.			Fibres Arranged in Order of Total Loss Produced by both Experiments.		
No.	Name.	Loss per cent after exposure for 2 hours in steam, at 15 lbs. extra pressure, followed by boiling in water (212°) for 3 hours.	No.	Name.	Loss per cent after further exposure, for 4 hours, to steam and water at 15 lbs. extra pressure.*	No.	Name.	Total loss per cent.
1.	Himalayan Hemp† (*Cannabis sativa ?*)	0·58	1.	China Nettle ..	None	1.	Himalayan Hemp†	0·77
2.	Rheea (*Boehmeria nivea*)	0·81	2.	Neilgherry Nettle	None	2.	China Nettle ..	0·89
3.	China Grass (*Boehmeria nivea*)	0·89	3.	Sunn	None	3.	Rheea	1·51
4.	Ambaree (*Hibiscus cannabinus*)	2·39	4.	Himalayan Hemp†	0·19	4.	Neilgherry Nettle	2·85
5.	Flax (*Linum usitassimum*)	2·47	5.	Ejoo	0·61	5.	Sunn	2·93
6.	Pine Apple (*Ananassa sativa*)	2·47	6.	Rheea	0·70	6.	Flax	3·50
7.	New Zealand Flax (*Phormium tenax*)	2·70	7.	Flax	1·03	7.	Ambaree	3·63
8.	Pita or Agave (*Agave Americana*) ..	2·72	8.	Bedolee Sutta ..	1·20	8.	Ejoo	4·15
9.	Sufet Bariala (*Sida rhomboidea*)	2·76	9.	Ambaree	1·24	9.	Bedolee Sutta ..	4·26
10.	Neilgherry Nettle (*Urtica heterophylla*)	2·85	10.	Moorva or Marool	2·03	10.	Muddar or Yercum	5·47
11.	Sunn (*Crotalaria juncea*)	2·93	11.	Dunchee	2·18	11.	Pita or Agave ..	5·55
12.	Bedolee Sutta (*Pederia fætida*)	3 06	12.	Jute	2·19	12.	Moorva or Marool	5·55
13.	Muddar or Yercum (*Calotropis gigantea*)	3·19	13.	Muddar or Yercum	2·28	13.	Sufet Bariala ..	6·00
14.	Italian Hemp (*Cannabis sativa*)	3·38	14.	Coir..	2·54	14.	Dunchee	6·07
15.	Manilla Hemp (*Musa textilis*)	3·38	15.	Manilla Hemp ..	2·69	15.	Manilla Hemp ..	6·07
16.	Plantain (*Musa paradisiaca*)	3·40	16.	Italian Hemp ..	2·86	16.	New Zealand Flax	6·14
17.	Russian Hemp (*Cannabis sativa*) ..	3·47	17.	Pita or Agave ..	2·83	17.	Italian Hemp ..	6·18
18.	Ejoo (*Arenga saccharifera*)	3·55	18.	Sufet Bariala.. ..	3·24	18.	Pine Apple	6·49
19.	Moorva or Marool (*Sanseviera zeylandica*)	3·72	19.	Plantain..	3·34	19.	Plantain	6·74
20.	Dunchee (*Sesbania aculeata*)	3·89	20.	New Zealand Flax	3·44	20.	Coir	8·13
21.	Yucca or Adam's Needle (*Yucca gloriosa*)	5·30	21.	Pine Apple	4 02	21.	Russian Hemp ..	8·44
22.	Coir (*Cocos nucifera*)	5·59	22.	Russian Hemp ..	4·97	22.	Yucca or Adam's Needle	10·87
23.	Pandanus or Screw-pine‡ (*Pandanus odoratissimus*)..	6·03	23.	Yucca or Adam's Needle	5·57	23.	Pandanus, or Screw-pine ..	12·21
24.	Jute (*Corqhorus olitorius; C. capsularis*)	19·20	24.	Pandanus or Screw-pine	6·18	24.	Jute	21·39

* In this case, the samples were partially immersed in the water, and the operation of boiling afterwards, to remove the portions loosened by the steam, was not required. In Experiment No. I., the fibres were placed entirely in the steam, then removed and boiled for three hours in water.

† Although, after careful examination, this is believed to be true hemp, still, looking to the very high place which it takes, as compared with that from Russia and Italy, it is quite possible that this opinion may be wrong. It will be noticed that Sunn fibre, which stands 11th in Experiment No. I., occupies the first rank in No. II. This "Himalayan hemp" is not the produce of a nettle, but it may, as originally suggested by Mr. Henry Cope, be that of the Sunn plant.

‡ This refers to the white, comparatively weak fibres, furnished by the leaves of the Screw-pine, not to the fibrous material yielded by the aërial roots which shoot downwards from its stem.

tions will permit, to what extent they contribute to the establishment of the general principle upon which they proceed.

In 1866 Tilghman patented a process for the preparation of paper pulp from wood, by heating with sulphurous acid solution, with or without a base, and at a pressure not exceeding that of the atmosphere. In his specification he builds upon two properties of this reagent as especially contributing to the result, viz.—(1) Its bleaching action upon vegetable as upon animal tissues; and (2) its specific action as an acid upon the constituents of the wood. This point of view involves no general theory of the chemical function of the substances operated upon: and the want of success which attended Tilghman's work is referable partly to their somewhat inadequate conception of the theoretical basis of his process. Augustus Mitscherlich took out in 1874 a German patent for treating wood with a solution of bisulphite of lime, and his process has met with considerable success. This chemist, in his specification, wisely avoids theoretical matters; at the same time, from the statement which it contains that the yield of cellulose from *Pinus sylvestris* amounts to 66 per cent of the weight of the wood, we are enabled to gather (1) that he effects a very incomplete resolution of the wood substance, not much more, indeed, than by means of water at the same temperature as that employed by him; and (2) that he attaches a very different meaning to the term cellulose from that which is current amongst chemists who have investigated this subject from the more purely theoretical point of view. We cannot see, therefore, that either of these processes was instituted upon a clear recognition of the chemical relationship of the reagents. The process also, which bears the name of Francke, is one which addresses itself rather to the main practical end of converting wood into paper pulp than to the establishment of a general principle, and therefore can only claim from us this passing notice.

Whatever be the minor issues of these several processes in their competition one with the other, they all offer a solution of the problem of preparing paper-pulp from wood

under reducing conditions, and constitute, therefore, together with the many obvious points of superiority of the products, both soluble and undissolved, and of its results, economically considered, a very strong indictment of the older methods; added to which, the confirmatory evidence drawn from the theoretical investigations of the constitution of lignified tissues makes the case for the sulphite method complete.

I must not omit to mention that there has been hitherto a practical objection to this process, which has been of sufficient weight to deter many from adopting it, who were on other grounds fully satisfied as to its superiority—this lay in the necessity of using a lead-lined jacketted boiler, a very costly piece of apparatus in the first instance, and one very liable in the next place to get out of order by displacement of the lining, and thus to cause serious interruptions. It has only recently become known to those engaged in developing this process that a metal has been in use now for several years, in the process of manufacturing glucose, which resists the action of dilute sulphuric acid boiling under pressure, and fulfils all the conditions demanded by the sulphite process for wood-pulp. Its adoption removes the only serious objection which could be urged against the many advantages which it offers.

Although we refrain from giving an opinion upon the relative values of the pulps produced by the several sulphite processes, it may aid in the formation of a correct estimate by those who have not given much attention to the theoretical side of the subject, to give a short account of the three chemical tests which afford the most valuable criterion of a pulp, apart from a direct observation of its working into paper. It is evident that its value increases in proportion as it approaches more nearly to the condition of pure cellulose. To detect residual lignose (1) the aniline sulphate test (yellow reaction) has been considered sufficient; but it must be pointed out that the "reduced" pulp often fails to give the reaction, even though it contain a large proportion of lignose, and that the only reliable test is (2) exposure to chlorine gas, followed by immersion in a solution of sodium sulphite, the lignose substances being hereby converted into a bright magenta-coloured derivative. The most reliable method is, however (3), the quantitative estimation of the cellulose by any of the standard methods, together with an observation of the behaviour of the cellulose in regard to boiling alkaline solutions, chiefly the loss in weight sustained on boiling in a solution of potash of standard strength for a constant interval of time. In regard to the latter test, it serves to reveal a very serious defect of some boiling processes, or of any boiling process improperly conducted, viz., the modification of a portion of the cellulose into derivatives having a gelatinous character or tendency, and which render a paper in which they are present brittle and hard. This modification is the result or the expression of a "hydration" of the cellulose, and appears to depend, to a great extent, upon the proportion of base to acid in the sulphite solution. The products in question are soluble in alkaline solutions, and thus the value of the test in revealing a defect which might otherwise be overlooked. Time will not permit us to discuss this question of wood boiling more fully.

In conclusion, we must devote a few words to the cognate subject of the isolation of fibres by means of "retting." This process is one that requires most delicate handling, and that whether the fibres to be separated are of the lignified (jute) or cellulosic type (flax, hemp). Those who are acquainted with the details of the conduct of this process will have been struck with the fact that it continues to be regulated by a traditional empiricism, that, for instance, a product of such great value and importance as flax should be left to the uncertain issues of a process which is calculated to do more or less damage to the fibre, according to variations in conditions which are only very imperfectly understood, and therefore controlled. It has been found, on the other hand, that these fibres can be isolated by means of the process of boiling, under pressure, with solutions of the sulphites, with results which have the great merit of being invariable. The process is simple, and capable of endless variation to suit the special circumstances of any given fibre. In this application, it is, as yet, only in its infancy; but the superior results which it promises call for the careful consideration of practical men, both agriculturists and manufacturers. When it is remembered that huge industries depend upon a first process of an essentially uncertain character; that the raw material which they employ is probably all, more or less, deteriorated by this process; and further, that the difficulties of dealing with the produce stand in the way of developments in agriculture, which might have an important influence on the future of this country, it is surely time that the matter received a thorough investigation.—*Journal of the Society of Arts.*

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, March 1, 1883.

Dr. GILBERT, F.R.S., President, in the Chair.

The following certificates were read for the first time:—J. A. Basker, E. C. Hemming, J. B. Coleman.

The full list of Officers and Council was read from the Chair. The changes contemplated are given in the report of the meeting on February 15. In that report the name of Prof. Dittmar was, however, inserted instead of H. T. Brown as a proposed member of the Council.

During the evening a ballot was held, and the Scrutators, Dr. Hodgkinson and Mr. Howard, declared the following gentlemen duly elected Fellows:—A. C. Abraham, G. Board, C. N. Betts, E. Bevan, F. J. Cox, A. Collenette, S. Dyson, W. T. Elliott, H. B. Fulton, C. G. Grenfell, B. F. Halford, W. D. Hogg, D. Hooper, J. J. Knight, H. F. Lowe, T. H. Leeming, J. E. Marsh, W. Newton, C. Rumble, F. Scudder, J. O'Sullivan, S. A. Vasey, T. D. Watson, R. M. Walmsley, C. S. S. Webster, F. Watts.

The following papers were read:—

"*On some Derivatives of the Isomeric* $C_{10}H_{14}O$ *Phenols*," by H. E. ARMSTONG and E. H. RENNIE. Lallemand stated (*Ann. Chem. Pharm.*, 101, 119) that by the action of a mixture of strong nitric and sulphuric acids on dinitro-thymol a trinitro-thymol was obtained. The authors have repeated this reaction, and find that a trinitro-body is produced, but that it is trinitro-meta-cresol, the propyl group being displaced. The authors were unable to trace this reaction. On comparing carvacrol with thymol, it is seen that the only difference is in the relative positions of the methyl and propyl groups. Only a dinitro-derivative could be obtained from carvacrol; no trinitro-body could be formed. An attempt was made to introduce the NO_2 group into the unoccupied ortho-position in thymol-sulphonic acid, but without success, as the sulpho-group is displaced by NO_2, and para-nitro-thymol is formed. When bromo-thymol-sulphonic acid is oxidised by chromic acid, a quinone is formed; with permanganate no formation of quinone takes place; some amorphous, probably condensation, products are produced. Dibrom-thymol, with cold nitric acid, forms a colourless substance, probably a nitroso-body. The authors have also investigated the nitro-bodies formed from isobutyl-phenol.

Dr. JAPP suggested that the propyl group, which was displaced by NO_2, might be eliminated as propylen, which was then polymerised by sulphuric acid.

The SECRETARY then read a paper entitled "*Chemico-Microscopical Researches on the Cell-contents of certain Plants*," by A. B. GRIFFITHS. The author has contrasted the growth of some savoy cabbages grown in a soil to which no iron was added with that of plants grown with

the addition of ferrous sulphate. The weight of the latter plants was about twice that of the former; the ash contained notable quantities of iron; in one case the stalk contained 3·521 per cent Fe_2O_3, and the leaves 12·29 per cent Fe_2O_3. Microscopical sections of the leaves exhibited minute crystals in some of the cells. On running potassium ferricyanide under the cover glass these crystals became blue, and after the addition of barium chloride a cloudiness was observed; the crystals also were monoclinic, so the author concludes that they were crystals of $FeSO_4+7H_2O$.

The following communication was read by the SECRETARY:—"*The Phenates of Amido-Bases*," by R. S. DALE and C. SCHORLEMMER. The author could not isolate any compounds intermediate between aurin and para-rosanilin, and have concluded, after many experiments, that when aurin is heated with aqueous or alcoholic ammonia, the action proceeds at once to the formation of rosanilin. When equal molecules of aurin and common rosanilin were heated with alcohol, a solution was soon formed, and on concentration a crystalline powder with dark green lustre separated, which proved to be rosanilin aurinate. Similarly, when equal molecules of aniline and phenol were heated for some hours to the boiling-point, aniline phenate, C_6H_7N,C_6H_6O, was obtained in glistening plates, melting at 29·5°, boiling at 184·5°; this substance has a faint phenol-like odour. A rosanilin phenate has been prepared by Mr. G. Dyson. Red alkaline solutions of aurin sometimes turn brown. On acidifying such a brown solution, a smeary mass is precipitated, from which a body was isolated in colourless crystals; it proved to be dioxy-phenyl-ketone, $CO(C_6H_4OH)_2$.

The Society then adjourned to March 15.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, March 5, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

THE Earl of Dalhousie, K.T.; James D. Bradshaw, M.A.; F. Werneck T. de Castro; Mrs. Elizabeth Dobson; Bryan Donkin, jun.; Miss Clara Gisborne; William Gonne; Major William Hanmer; Walter Harris; Sir Charles Brodie Locock, Bart.; George Henry Pinckard; and Charles Richardson were elected Members of the Royal Institution. Two candidates for membership were proposed for election.

The following arrangements for the Lectures after Easter were announced:—

Prof. John G. McKendrick, M.D., F.R.S.E., Fullerian Professor of Physiology, R.I.—Ten Lectures on "Physiological Discovery: A Retrospect, Historical, Biographical, and Critical;" on Tuesdays, April 3, 10, 17, 24; Monday, April 30; Tuesdays, May 8, 15, 22, 29, and June 5.

Dr. Waldstein, Hon. M.A. Cantab.—Three Lectures on the "Art of Pheidias;" on Thursdays, April 5, 12, 19.

Prof. Tyndall, D.C.L., F.R.S.—Three or four Lectures; on Thursdays, April 26, and May 3, 10, 17.

Reginald Stuart Poole.—Three Lectures on "Recent Discoveries in (1) Egypt, (2) Chaldæa and Assyria, (3) Cyprus and Asia Minor; on Thursdays, May 24, 31, and June 7.

Archibald Geikie, LL.D., F.R.S.—Six Lectures on "Geographical Evolution;" on Saturdays, April 7, 14, 21, 28, and May 5, 12.

Prof. C. F. Turner, of the University of St. Petersburg.—Four Lectures. "Historical Sketches of Russian Social Life;" on Saturdays, May 19, 26, and June 2, 9.

The presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 9, 1883.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

DR. JOULE said that he had, in December, 1882, made a fresh determination of the freezing-point in a sensitive thermometer constructed thirty-nine years ago. During that time the point had risen about 1° F., and although now rising very slowly, was not even yet quite stationary, having risen 1-40th of a degree Fahrenheit since November, 1879.

Ordinary Meeting, January 23, 1883.

J. P. JOULE, D.C.L., LL.D., F.R.S., &c., Vice-President, in the Chair.

"*Remarks on the Simultaneous Variations of the Barometer recorded by the Late John Allan Broun*," by Prof. BALFOUR STEWART, F.R.S.

Ordinary Meeting, February 6, 1883.

Prof. BALFOUR STEWART, LL.D., F.R.S., in the Chair.

"*Note on the Vapours of Incandescent Solids*," by HENRY WILDE.

It is generally admitted that the phenomena known as Moser's spectral images, which make their appearance on polished metallic surfaces when bodies are placed very close thereto, are attributable to the general property which solid bodies possess of giving off vapours of their own substance at common temperatures, and the peculiar odours emitted by some of the less volatile metals, such as copper, when subjected to friction or to the action of cutting tools, are also assignable to the like cause.

The production of Moser's images, as has been shown, is greatly assisted by the application of heat, and it might have been anticipated that at high temperatures the most dense and refractory substances would vapourise while retaining their solid form.

The conditions necessary for observing the behaviour of solids at high temperatures are well brought about in the modern form of incandescent electric lamp. This lamp consists of a bulb of glass from which the air is exhausted to the highest degree attainable, and a filament of metal or carbon is mounted in the bulb, and rendered incandescent by the action of the electric current.

Platinum, from its high degree of infusibility, was considered by some the most suitable substance for the luminous filament, and great expectations were formed, that by its use the problem of incandescent lighting would be solved. It was, however, found that an atmosphere of platinum vapour was formed in the interior of the bulb, which, after the lamp had been in action a lengthened number of hours, condensed on the surface of the glass and formed a bright reflecting surface like a mirror.

This property of the platinum, while affording a remarkable illustration of the vapourisation of a dense body while retaining its solid form, was fatal to its use as an illuminant, as the density of the film of platinum on the surface of the glass ultimately obstructed the greater portion of the light from the filament itself.

Chemists, I believe, are not unanimous in opinion as to whether elementary carbon ever passes from the solid to the liquid form.

Some years ago, I frequently made the experiment of concentrating upon a small pencil of carbon, 2 inches long and 3-20ths of an inch in diameter, an amount of

electric force sufficient to fuse a rod of platinum 2 feet long and ½ of an inch in diameter.

The light from the pencil was of intense whiteness, but the carbon showed no signs of fusion, and rapidly diminished in thickness by combination with the oxygen of the air.

The substitution of a filament of carbon for platinum has now placed the incandescent electric light in the rank of recognised illuminants, and when not raised to too high a temperature the carbon filament is very durable. When, however, a high degree of incandescence is attained, an atmosphere of carbon vapour is formed in the interior of the bulb which condenses on the glass and forms a dark lustrous surface which obstructs the light in the same manner as when a filament of platinum was employed.

The behaviour of the carbon and the platinum in each of these lamps clearly shows that the most dense and refractory substances in nature vapourise at high temperatures while still retaining their solid form.

Electric lamps were exhibited by Mr. Wilde showing the condensed platinum and carbon on the interior surfaces of the glass bulbs.

CORRESPONDENCE.

A CORRECTION.

To the Editor of the Chemical News.

SIR,—In my letter on the solubility of ammonio-magnesic phosphate (CHEMICAL NEWS, vol. xlvii., p. 71), I notice a misprint at the end of the article. It should read:—

1000 c.c. 1 p.c. ammonia water dissolve 0·88 *m.grm.* P_2O_5.
1000 „ 2 „ „ „ 0·23 „ „
1000 „ 3 „ „ „ 0·15 „ „

The mistake is so flagrant that it would be noticed at once by anyone at all conversant with the determination of phosphoric acid; still, it is well to call attention to it.—I am, &c.,

THOMAS S. GLADDING.

55, Fulton Street, N.Y.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 5, January 29, 1883.

Contributions to the History of the Reactions between Sulphur, Carbon, their Oxides, and their Salts.—M. Berthelot.—The author has allowed these substances to act upon each other at a red heat, and observed the decompositions and combinations effected.

Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—The author takes 20 grms. of the soil, finely powdered and sifted through silk, and attacks it in a porcelain capsule with hydrochloric acid diluted to one-fifth as long as there is effervescence. He then adds 80 c.c. of an *aqua regia* solution made up of 3 parts of hydrochloric to 1 part of nitric acid. He digests on the water-bath until the liquid takes a syrupy consistence, dilutes with cold distilled water, and washes on the filter with boiling water. The filtrate is then precipitated with caustic ammonia in excess. The precipitate, collected and dried, is ignited to cherry-redness in a platinum crucible, pulverised, re-dissolved in very dilute nitric acid (1-40th), and after digestion in the cold it is filtered. The filtrate, freed by the preceding operations from lime, iron, and silica, contains the whole of the phosphoric acid. It is concentrated on the water-bath to bring it to a volume fit for the molybdic process. The phospho-molybdic precipitate, not being contaminated with a solution of salts of iron, aluminium, and calcium, and being absolutely free from silica, may after a single washing be re-dissolved in ammonia, and the phosphoric acid precipitated with magnesia mixture in the usual manner.

Reply to the Memoir of M. Marcel Deprez.—M. Maurice Lévy.—A continuation of the controversy on the Munich experiments.

Reply to the Observations Presented by M. M. Lévy in his Note of January 22, 1883.—MM. E. Mercadier and Veschy.—A discussion on the various systems of electric unities.

New Experiments on Electrolysis.—E. Semmola.—The author adapts to an ordinary voltameter the platinum electrodes, *a*, *b*, *c*, quite identical, and arranged triangularly at the bottom of the voltameter; one of the electrodes, *c*, is placed in connection with the positive pole of the battery, and the two others, *a* and *b*, communicate with the contacts of a commutator. The movable contact of this commutator is formed by a small metal bar in connection with the negative pole of the battery, and can either unite or separate the two electrodes, *a* and *b*, not connected with the battery. When the little bar disconnects these electrodes, the current of the battery passes directly from *c* to *b*, as in ordinary voltameters, and returns to the battery by the barette of the commutator. The electrode *a* being isolated from the circuit plays, then, no part. But when this bar is lowered upon the second contact of the commutator in connection with the electrode *a*, the current, on arriving at the first electrode, *c*, is bifurcated so as to regain simultaneously the two electrodes, *a* and *b*, and proceed thence to the battery. On measuring the quantity of hydrogen liberated under each of the jars corresponding to the two electrodes, *a* and *b*, their sum is found exactly equal to the quantity collected under *b* alone, when the entire current is passed through the electrode *b*.

Researches on the Passage of Alcoholic Liquids through Porous Bodies (Second Memoir).—H. Gal.—An alcoholic liquid, in contact with a membrane, in place of becoming concentrated, as Sœmmering stated, and as is generally taught, becomes weaker, as does also its vapour. This latter phenomenon, which may seem paradoxical, considering the difference of density of the vapours of alcohol and of water, is explained sufficiently if we remember the considerable difference existing between the tensions of aqueous vapours and of alcoholic vapours at all temperatures, and if we keep in mind that in air, alcohol encounters a space containing not a trace of its own vapour, whilst water finds an atmosphere already more or less saturated.

Vapours of Carbamide.—M. Isambert.—The author has studied the compressibility of the vapour emitted by carbamide. They behave like a mixture of ammoniacal gas and carbonic acid.

Manganese Sulphite.—Alex. Gorgeu.—The author has obtained two sulphites containing respectively 1 and 3 mols. of water. They combine easily with the alkaline sulphites, forming crystalline double salts.

New Ammonio-Cobaltic Combinations.—M. Maquenne.—The author forces a current of ozonised oxygen through an ammoniacal solution of cobalt sulphate. The liquid becomes, first brown, and then green, and a green salt is deposited on the sides of the tube in prismatic tables, or, if cobalt chloride has been used instead of the sulphate, in fine needles. These compounds are probably acid salts of Fremy's oxy-cobaltia.

Mutual Displacements of Bases in Neutral Salts, the Systems remaining Homogeneous (Second Memoir).—N. Menschutkine.—This paper will appear in full

Crystalline Form, Specific Heat, and Atomicity of Thorium.—L. F. Nilson.—Will be inserted in full.

No. 6, February 5, 1883.

Certain Combinations of Manganese Sulphite with Alkaline Sulphites.—A. Gorgeu.—The author has examined the potassium-manganese, ammonium-manganese, and sodium-manganese double sulphites.

Hydraulic Silica: a Reply to M. Le Chatelier.—Ed. Landrin.—A prolonged discussion on priority.

Mutual Displacements of the Bases in Neutral Salts, the Systems remaining Homogeneous (Third Memoir).—N. Menschutkine.—This memoir will be inserted in full.

Journal für Praktische Chemie.
New Series, Vol. xxvi, Part 8, No. 19, 1882.

Cyanæthine, and New Basic Derivatives (Second Memoir).—Ernst von Meyer.—By heating cyanæthine with hydrochloric acid, one of its atoms of nitrogen is replaced by hydroxyl, forming an *oxy-base*. Both this base and cyanæthine itself may be regarded as derivatives of cyanconiine. The author describes this body; the behaviour of cyanæthine with nitrous acid, with methyl-iodide, the action of iodalkylen and ethylene bromide upon the oxy-base; the action of bromine upon cyanæthine, mono-bromo-cyanæthine, iso-adipic acid, and the behaviour of the oxy-base with bromine and potassa.

Trimethylene.—Aug. Freund.—The author endeavours to obtain an isomer of propylene by the action of sodium upon trimethylene bromide. He obtained a gas not identical with ordinary propylene, though having the same composition, C_3H_6.

Ethylen-chlor-bromide and the Derivatives of Ethylen-chlor-sulpho-cyanide.—Dr. J. W. James.—The author describes the method of preparing ethylen-chlor-bromide adopted by Maxwell Simpson, the action of sodium sulphite upon ethylene-chloro-sulpho-cyanide, the formation of sulpho-cyan-ethyl-sulphonic acid, and the salts of β-chlor-ethyl-sulphonic acid.

Preliminary Communication.—Dr. W. Ostwald.—Induced by the papers of Menschutkin and L. Meyer contained in the last number of the *Berlin Berichte*, on the formation and decomposition of the amides or anilides, I am compelled to mention that I have been working for half a year on the action of acids upon amides, and especially upon acetamide. There is formed during this reaction, an ammoniacal salt; the rate of the transformation depends upon the nature of the acid, and is in a very simple relation to the magnitude, which I have called the "relative affinity," being approximately proportional to its square. The analytical method for determining the ammoniacal salt along with the undecomposed amide consists in treatment with sodium hypobromite in the azotometer, whereby the amide undergoes no change, whilst the nitrogen of the ammonia is at once liberated. In this manner I have succeeded in a measurement of the magnitudes of affinity by the corresponding speeds, whilst the methods hitherto employed assume a chemical equilibrium, *i.e.*, a speed = 0. Here appear the rudiments of chemical dynamics in conjunction with the statical phase of the science, which has hitherto been exclusively cultivated.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 4, 1882.

Determination of Oxygen in Iron.—A. Ledebur.—This paper requires the accompanying diagram.

Lead in Samples of Tin.—M. Roux.—From the *Bulletin de la Soc. Chimique.*

Determination of Sugar in Separation Mud.—A. Nord.—Instructions for the complete extraction of the sample.

Determination of Chloric Acid in Bleaching Lime.—E. Dreyfuss.—From the *Bulletin de la Soc. Chimique.*

Determination of Sugar in Calcium Saccharate.—K. Stammer.—The author grinds up the sample with water to a homogeneous paste, adds rosolic acid as indicator, and drops in glacial acetic acid until the solution is faintly acid. It is then so colourless that it can be examined with the polariscope. The proportion of lime is ascertained alkalimetrically with normal nitric acid.

Comparison of the Value of Extracts of Logwood.—M. Reinhard.—The author determines the proportions soluble respectively in water, in ether (hæmatoxyline), and in alcohol (hæmatine). It is mentioned that Sanford's extract contains 3 per cent less hæmatoxyline, 10 per cent less hæmateine, 7 per cent more insoluble residue, and 5 per cent more water, than the French extract.

Adulteration of Logwood-Extract with Treacle, Glucose, &c.—E. Lauber adds yeast to the solution, and, after the fermentation is over, determines the alcohol.

Detection of Adulteration of Orchil with Aniline-red—G. Heppe adds to the aqueous solution picric acid, which throws down aniline-red and violet, but does not precipitate pure extract of orchil. If the precipitate is very slight it does not subside for some days, but it gives the liquid a brown turbidity when examined by reflected light.

Use of Citric Acid in the Analysis of Phosphates.—A. Grupe, A. von Ollech, and B. Tollens.—This memoir is merely mentioned.

Determination of Protein Compounds.—A. Stutzer.—One gramme of the substance is comminuted, sifted through a fine sieve, placed in a beaker with a mixture of 1 c.c. acetic acid and 100 c.c. alcohol, heated to a boil, and when cold decanted through a smooth filter, so that little or none of the insoluble matter may come upon the filter, which is then repeatedly washed with warm alcohol to remove acetic acid and dissolved fat, and set aside. The residue in the glass is covered with 100 c.c. of water, heated to a boil, mixed when half cold with 0·3 to 0·4 grm. hydrated copper oxide, filtered through the former filter, and washed. All the non-proteinic nitrogenous matter passes into solution. The precipitate is dried at 100° to 110°, and its nitrogen determined by combustion in the ordinary manner. The nitrogen in the non-proteinic compounds may be found by difference.

Quantitative Determination of the Albumenoids and of the Non-Albumenoid Nitrogen Compounds.—E. Schulze.

New Contributions to a Knowledge of the Nitrogenous Constituents of Potato Tubers.—E. Schulze and E. Eugster.

Determination of Woody Fibre.—C. Krauch and W. v. d. Becke. - The above three papers are merely mentioned.

Alkalies in Silver Nitrate.—Fr. Stolba dissolves the sample in a minimum of water, and adds to the clear solution hydro-fluosilicic acid. A turbidity or a precipitate shows the presence of alkalies.

Examination of Commercial Pancreatin.—D. C. Moriarta.—From *New Remedies.*

Determination of Morphine in Opium.—E. Mylius.—Into each of two test-tubes fitted with corks are put 5 drops of concentrated solution of iodic acid, then 5 c.c. of rectified carbon disulphide. Lastly, into one tube are put 10 c.c. of a solution of pure morphine, and into the other 10 c.c. of an extract of the sample. The tubes are corked, and both tubes are shaken up for exactly the same time, two to three minutes. The colours are then compared. If both are equal the opium contains 10 per cent morphia. If they are unequal, the more deeply coloured solution is let down with carbon disulphide till the colours are equal. The proportion of morphine is then deduced from the volume of the liquid, which is readily seen when graduated tubes are used. The solution of morphine

taken as a standard is made by dissolving 0·1 grm. morphine with 3 grms. dilute sulphuric acid in 100 c.c. water. For extracting the sample, 0·5 grm. in powder are boiled with 10 grms. water in a 50 c.c. flask, mixed with 3 grms. basic lead acetate, made up to 50 c.c. with cold water, well shaken up, filtered, and the entire filtrate precipitated with 15 drops sulphuric acid. The liquid is filtered again, and must be absolutely clear.

Examination of Benzoic Acid.—P. W. Bedford.—From the *Pharmaceutical Journal*.

Methods relating to Physiology and Pathology.—F. Hofmeister.

Determination of Urea with Sodium Hypobromite.—F. Hofmeister.—From the *Moniteur Scientifique*.

Detection of Sugar in Urine with Alkaline Solution of Copper.—Worm Müller.—The author recommends the following modified process:—5 c.c. of filtered urine, freed from albumen, are measured with a pipette, and heated to a boil in a test-tube. At the same time, a mixture of 1 to 1·5 c.c. of the copper solution and 2·5 c.c. of alkaline solution of salt of Seignette (potassium-sodium tartrate) is boiled. The boiling in both liquids is broken off at once, and after twenty to twenty-five seconds they are mixed together. Immediately after mixing the liquid generally appears of a blue-green, and the separation of cuprous oxide takes place at once, or within five to ten minutes. The cuprous oxide generally takes the form of a fine precipitate, which by reflected light appears as a greenish yellow turbidity. If no precipitate appears the test is repeated with increased quantities of the copper solution, 2, 2·5, 3 c.c. &c.

Metalbumen and Paralbumen.—O. Hammarsten.—The author has made an elaborate investigation of the fluids of a series of ovarian cysts, consisting chiefly of Scherer's metalbumen and paralbumen.

Methods relating to Chemical Jurisprudence..

Detection of Chloroform.—D. Vitali.—Pure hydrogen gas is passed through a retort, in which the substance in question is distilled. The hydrogen gas thus charged with chloroform is either examined for chlorine by combustion, or submitted to Hofmann's iso-nitril reaction, or passed through a freshly prepared mixture of thymol and solid potassa. If chloroform is present this mixture will be coloured a fine reddish violet.

The Ptomaines.—P. Brouardel and E. Boutmy.—From the *Comptes Rendus*.

Examination of Handwriting.—W. Thomsen.—From the CHEMICAL NEWS.

MEETINGS FOR THE WEEK

SATURDAY, 11th.—Physical, 3. "On a Method of Measuring Electrical Resistances with a Constant Current," by Shelford Bidwell. "On some Uses of a New Projection Lantern," by Mr. W. Lant Carpenter.
MONDAY, March 12.—London Institution, 5.
— Medical, 8.30.
TUESDAY, 13th.—Royal Institution, 3. "The Supreme Discoveries in Astronomy (The Astronomical Significance of Heat)," by Professor R. S. Ball.
— Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
WEDNESDAY, 14th.—Society of Arts, 8.
— Microscopical, 8.
THURSDAY, 15th.—Royal Institution, 3. "The Spectroscope and its Applications," by Professor Dewar.
— London Institution, 7.
— Royal, 4.30.
— Royal Society Club, 6.30.
— Chemical, 8. On some Condensation-Products of Aldehyds with Aceto-Acetic Ether and with Substituted Aceto-Acetic Ethers," by Mr. F. E. Matthews.
FRIDAY, 15th.—Royal Institution, 8. "Thoughts on Radiation, Theoretical and Practical," by Prof. Tyndall, at 9.
SATURDAY, 17th.—Royal Institution, 3. "Music as a Form of Artistic Expression," by Mr. H. H. Statham.

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1216.

NOTES ON THE ABSORPTION OF ULTRA-VIOLET RAYS BY VARIOUS SUBSTANCES.*

By GEORGE D. LIVEING, F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

THE following notes contain some records of ultra-violet absorptions in addition to those which have been examined by Soret, Hartley, M. de Chaudonnet, and other investigators. For these observations we have generally used the spark of an induction coil, with Leyden jar, between iron electrodes as the source of light. Occasionally we have used other electrodes, but the lines of iron are so multitudinous, and so closely set in a large part of the ultra-violet region of the spectrum, that they form almost a continuous spectrum, at the same time there are amongst them a sufficient number of breaks and conspicuous lines to serve as points of reference. The spectroscope has a single prism of quartz, and the telescopes have quartz lenses. The image of the spark was projected on to the slit of the spectroscope by a quartz lens, and the absorbent substances were interposed between the slit and the last-mentioned lens. The gases were held in tubes fitted, some with quartz, others with rock salt, plates on the ends; liquids in cells with quartz sides. The spectra were all photographed.

Chlorine in small quantity shows a single absorption band extending from about N (3580) to T (3020). As the quantity of chlorine is increased this band widens, expanding on both sides, but rather more rapidly on the less refrangible side. Different quantities of chlorine produced absorption from about H (3968) to wave-length 2755, from wave-length 4415 to 2665, and from wave-length 4650 to 2630. With the greatest quantity of chlorine tried the absorption did not extend above wave-length 2550.

Bromine vapour in small quantity absorbs light up to about L (3820), and is quite transparent above that. With larger quantity the absorption increases, gradually extending with increase of bromine vapour from L to P (3360); and at the same time there is a gradually increasing general absorption at the most refrangible end of the spectrum, beginning at about wave-length 2500; so that the denser bromine vapour is transparent for a band between wave-length 2500 and 3350.

Liquid bromine in very thin film between two quartz plates is transparent for a band between wave-length about 3650 and 3400, shading away on both sides, so that below M on one side and above P on the other the absorption seems complete. The transparency of the liquid film ends on the more refrangible side just where that of the vapour begins.

Iodine vapour tolerably dense cuts off all within the range of our photographs below wave-length 4300, and its absorption gradually diminishes from that point up to about wave-length 4080, from that point it is transparent. Denser vapour produces complete absorption up to 4080 and partial absorption above that point.

Iodine dissolved in carbon disulphide is transparent for a band between G and H, cutting off all above and below. It is not possible to tell how much of the light above M (3727) is absorbed by iodine in such a solution, inasmuch as carbon disulphide is opaque for rays more refrangible than M.

Iodine dissolved in carbon tetrachloride when the solution is weak, shows only the absorption due to the solvent described below. More iodine increases the absorption until it is complete above P (3360), with shading edge as far down as about wave-length 3400.

Sulphurous acid gas produces an absorption-band which is very marked between R (3179) and wave-length 2630, and a fainter absorption extending on the less refrangible side to O (3440), and on the other side to the end of the range photographed, wave-length 2300.

Sulphuretted hydrogen produces complete absorption above wave-length 2580. Below that a partial general absorption.

Vapour of carbon disulphide in very small quantity produces an absorption-band extending from P to T, shading away at each end; no absorption in the higher region. With more vapour the absorption-band widens, extending from about wave-length 3400 to 3000, and a second absorption occurs beginning at about wave-length 2580, and extending to the end of the range photographed.

Carbon tetrchloride liquid produces an absorption-band with a maximum about R, extending, but with decreasing intensity, up to Q (3285) on one side, and to *s* (3045) on the other. In the higher region there is a second absorption sensible about wave-length 2600, and increasing in intensity up to about wave-length 2580, beyond which point it is complete.

Chlorine peroxide gives a succession of nine shaded bands, at nearly equal intervals, between M and S, with faint indications of others beyond. In the highest region this gas seems quite transparent.

A slice of chrome-alum a quarter of an inch thick, is transparent between wave-lengths 3270 and 2830, its absorption gradually increases on both sides of those limits, but rather more rapidly on the more refrangible side than on the other, and becomes complete below about wave-length 3360 and above wave length 2730.

A very thin plate of mica shows absorption beginning about S (3100), rapidly increasing above U (2947), and complete above wave-length 2840.

A thin film of silver precipitated chemically on a plate of quartz transmits well a band of light between wave-length about 3350 and 3070, but is quite opaque beyond those limits on both sides.

A thin film of gold similarly precipitated merely produces a slight general absorption all along the spectrum.

The difference between the limits of transparency of Iceland spar for the ordinary and extraordinary rays we find to be very small, and hardly to be detected without using a considerable thickness, three inches or more, of the spar.

We had expected to be able to apply the well-known photometric method by means of polarised light to the comparison of intensities of ultra-violet rays. Ordinary Nicol's prisms are not applicable to ultra-violet rays on account of the opacity of the Canada balsam, with which they are cemented, but through the kindness of the President of the Society, we obtained from him the loan of a pair of Foucault's prisms. Upon taking photographs of the spectrum of the iron spark through this pair of prisms at various inclinations between the planes of polarisation of the two prisms, we found that for the whole range between the position of parallelism and the inclination of 80° there was no sensible difference of effect upon the photographic plate, though the length of exposure was in all cases the same. For inclinations between 80° and 90° there was a sensible and increasing diminution in the photographic effect as the planes of polarisation of the polariser and analyser were more nearly at right angles to one another. It seems to follow from this that the full photographic effect ensues when the intensity of the light reaches a certain limit, but that for intensities of light beyond that limit there is no sensible increase in the effect until the stage of solarisation is reached.

* A Paper read before the Royal Society, March 8, 1883.

Benzoyl Mesitylene.—E. Louise.—This compound has the composition $C_{16}H_{16}O$.—*Comptes Rendus.*

NOTE ON THE

REVERSAL OF HYDROGEN LINES; AND ON THE OUTBURST OF HYDROGEN LINES WHEN WATER IS DROPPED INTO THE ARC.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

THE concentration of the radiation of hydrogen in a small number of spectral lines would lead us to expect that the absorption of light of the same refrangibility as those lines would, at the temperature of incandescence, be correspondingly strong, and that therefore the hydrogen lines would be easily reversed. The mass of hydrogen which we can raise to a temperature high enough to show the lines is, however, so small, that notwithstanding the great absorptive power of hydrogen for the rays which it emits, the reversal of the lines has not hitherto been noticed. We find, in fact, that the lines are very readily reversed, and the reversal may be easily observed.

When a short induction spark is taken between electrodes of aluminium or magnesium in hydrogen at atmospheric pressure, a large Leyden jar being connected with the secondary wire of the coil, the hydrogen lines show no reversal; but if the pressure of the hydrogen be increased by half an atmosphere, or even less, the lines expand and a fine dark line may be seen in the middle of the F line. As the pressure is increased this dark line becomes stronger, so that at two atmospheres it is very decided. As the F line expands with increase of pressure the dark line expands too and becomes a band. It is best seen when the pressure is between two and three atmospheres. When the pressure is further increased the dark band becomes diffuse, and at five atmospheres cannot be distinctly traced. No definite reversal of the C line was observed under these circumstances. The dispersion used, however, was only that of one prism.

By using a higher dispersion the reversal of both the C and F lines may be observed at lower pressures. For this purpose we have used a Plücker tube, filled with hydrogen and only exhausted until the spark would pass readily when a large jar was used.

The light of the narrow part of the tube is, under these circumstances, very brilliant, while the spark in the broad ends is wider and less bright, but does not fill the tube. On viewing such a tube end on, and projecting the image of the narrow part of the tube on to the slit of the spectroscope, a continuous spectrum, of the width of the image of the narrow part of the tube, is seen, besides the lines of hydrogen given by the discharge in the wide part of the tube. These lines extend above and below the narrow continuous spectrum if the electrode is well placed, so that half an inch or so of the spark in the wide part of the tube may intervene between the narrow part of the tube and the spectroscope. The continuous spectrum of the narrow part of the tube seems due chiefly to the expansion of the hydrogen lines when the discharge occurs in so confined a space, and it is much brighter than the lines given by the spark in the wide part of the tube. Where the latter cross the continuous spectrum a very evident absorption occurs. We have observed it with a diffraction grating. The C line in the third order falls so near the F line in the fourth that both may be observed together. F is much more expanded than C, and the reversal consequently less marked, though quite plain. The other lines being still more diffuse their absorption could not be traced.

We have before observed (*Proc. Roy. Soc.*, vol. 30, p. 157) that the C and F lines of hydrogen are visible in the arc of a De Meritens magneto-electric machine taken in hydrogen; though in the arc of a Siemens machine the C line can only be detected at the instant of breaking the arc, the F line hardly at all. When, instead of taking the arc in hydrogen, small drops of water are allowed to fall from a fine pipette into the arc taken in air in a lime crucible, each drop as it falls into the air produces an explosive outburst of the hydrogen lines. Generally the outburst is only momentary, but occasionally a sort of flickering arc is maintained for a second or two, and the hydrogen line C is visible all the time. The lines (C and F) are usually much expanded, but are frequently very unequally wide in different parts of the line. F is weaker, more diffuse, and more difficult to see than C, and is visible for a shorter time. There is no sign of reversal. In the explosive character of the outburst, and the irregularity in the width of the lines, the effect resembles that of an outburst of hydrogen in the solar atmosphere. The elements of the water are, as we must suppose, separated in the arc, but from the explosive character of the effect they are not uniformly distributed in the arc. The arc being horizontal, and the image of it projected on to the slit of the spectroscope, it was really a very small section of the arc which was under observation, and this renders the variation in the width of the lines the more remarkable.

* A Paper read before the Royal Society, March 8, 1883.

ON THE DIFFUSION OF GASES.

By K. WAITZ.

THE author's results may be thus summed up:—The coefficient of diffusion for the free diffusion of two gases into each other is no constant magnitude. After the commencement of diffusion it decreases with time in any given section of the containing vessel, and soon reaches a limit of value which is constant for every section. The change of these limits of value from one section to another ensues proportionally to the distance of such sections from the free surface of the diffusion-vessel.—*Wiedemann's Annalen*, 1882, p. 201.

ON THE

CRYSTALLINE FORM, THE SPECIFIC HEAT, AND THE ATOMICITY OF THORIUM.

M. L. F. NILSON.

IN a former memoir I have described the principal properties of metallic thorium as prepared in a crucible of soft iron by the action of sodium upon the potassium-thorium chloride. The microscope shows minute slender laminæ, of a silvery lustre, mixed with the greyish powder of the metal, and consisting of a multitude of small tables of a hexagonal aspect. M. Brögger, after a very minute examination, has succeeded in showing that they form a regular combination between the octahedron and the tetrahedron—a fact the more interesting, as silicon crystallises in the same form, and that a remarkable analogy thus exists between these two elements.

The density of the metal found in the upper parts of the cavity of the crucible, and which on oxidation absorbs 11·1 per cent of oxygen was = 10·7824; that of the metal enclosed in the melted sodium chloride in the lower part of the crucible = 11·00. I supposed then that the lower density of the kind first mentioned was due to thoria mixed with it, the density of the latter being = 10·22; or, secondly, that the metal of the latter was almost pure. But the two specimens were found to have an almost identical composition. Hence it is clear that the difference of densities depends merely on the more definite crystallisation of the brighter metal of 11·00. The density of pure metallic thorium = 11·230 for the bright and 10·968 for the dull variety. It follows, therefore, that the atomic volume of thorium = 20·94, a value which approaches that of zirconium, cerium, lanthanum, and didymium, and that the

atomic heat of oxygen in thoria (thorium oxide) = 4·08, almost the same value as in zirconium, silicium, ceric, titanic, stannic, and manganic oxides.

I have determined the specific heat of thorium with the ice-calorimeter, using 3·1752 grms. of the metal of the density 11·000, enclosed in a small glass capsule weighing 0·7151 grm. After being heated for an hour by steam to the temperature T, as determined by a Geissler thermometer, and perfectly in harmony with the pressure B, the capsule was thrown into the calorimeter, and when cooled down to 0° produced changes on the position of the mercurial thread upon its scale in millimetres M. (The author gives a table of the heats, pressures, and thermometric changes noted in his experiments.)

The specific heat of the glass employed having been determined as 0·1989, and that of pure thoria as 0·0548, whilst the metal operated upon consisted of 0·0266 Fe, 0·6303 ThO_2, and 2·5183 Th. Hence it was calculated that this quantity of pure thorium, if cooled from 100° to 0° would disengage 6·942 cals., its specific heat being 0·02757. If we apply the law of Dulong and Petit to the specific heat found, we may evidently conclude that thorium is quadrivalent, for the mean value of the atomic heat of Th = 232·4, calculated according to the law, is 6·38, the experimental mean being 6·41. Hence it is proved that thorium, with its sole oxide ThO_2, finds its true place among the quadrivalent elements.—*Comptes Rendus*, xcvi., p. 346.

STEEL CASTINGS.

By SERGIUS KERN, M.E., St. Petersburg.

THE process of manufacturing steel castings is very carefully kept secret at all works engaged in such a business. We have had several interesting papers by M. Pourcel, of Terrenoire, France, but he gives nearly nothing about the *modus operandi*. We understand well that a man is not expected to say everything about his method if it brings him £ *s. d.* In Russia, very few steel castings were made at some works, and these may be called only experimental. We have lately received some information of a process of moulding for steel casting, the invention of Mr. George Cowing (*Journal of the Iron and Steel Institute*, No. 2, 1882, p. 731). Quartz from Finland (a very pure specimen) was calcined, ground to a rather fine powder, and mixed with from 2 to 3 per cent of glue water and flour. This was used for moulding.

As a facing fine quartz powder, with a small quantity of graphite well mixed with water, was used. The steel was prepared as follows:—80 lbs. of good iron, containing about 0·10 per cent of carbon,* was melted in a crucible; and were next added—2 lbs. of silicon pig-iron, containing 6·5 per cent of silicon, and 0·5 lb. of ferro-manganese, containing 75 per cent of manganese. The metal was kept in the furnace, with the alloy, for about fifteen minutes, and it was next poured into the moulds. The castings had a very clean surface, and were good.

My opinion is, that the clean surface depends much upon the moulding material. There is certainly a reaction between the silica and the gases. Secondly, as the quartz *expands* by heat, it gives a free passage to gases, and at the same time compresses the casting.

Certain Vegetable Poisons.—A. Bassiner. — The author has studied the so-called oil of *Ranunculus sceleratus*, anemonine (from *Anemone pulsatilla*), and cardol (from *Anacardium orientale*). All these poisons are destroyed by the action of potassa, so that they cannot occasion mistakes when searching for cantharidine by Radecki's process.—*Zeitschrift.*

* We propose to use soft basic steel.

ON THE

USE OF LITMUS, METHYL-ORANGE, PHENACETOLIN, AND PHENOL-PHTHALEIN AS INDICATORS.*

By ROBERT T. THOMSON.

THE number of indicators which have been proposed to supersede litmus is now very great, but none, so far as I am aware, have been thoroughly tested as regards their efficiency in presence of the impurities which constantly occur in the alkaline hydrates and carbonates of commerce. There is no lack of information to be obtained concerning the high tinctorial power of these indicators compared with that of litmus, and their delicacy when employed in the determination of alkalies in solutions of the pure hydrates and carbonates. But on the question of their value in presence of sulphites, thiosulphates, sulphides, phosphates, silicates, aluminates, &c., little or no attention has been bestowed.

In the following paper are detailed the results of a series of experiments I carried out with a view of testing, in as complete a manner as possible, the merits of litmus, methyl-orange, phenacetolin, and phenol-phthalein as indicators in the estimation of alkalies and certain free acids. Instead of taking these indicators in succession, and recording all the tests made with them, I have considered it preferable to take the substances which were tested by the standard acid or alkali, and state the results obtained with each indicator. By this means a close comparison of the behaviour of the different indicators with the same substance will be secured.

The tests were made in such a way that the solution employed would measure about 100 c.c. when the end-reaction was observed. The strengths of the indicator solutions (0·5 c.c. of which was used for every experiment) were so arranged that equal volumes of each gave, as nearly as could be judged from their different tints, the same intensity of colour at the point at which the change caused by the addition of excess of acid or alkali was just complete.

I. *Delicacy of the Indicators in Absence of Interfering Agents.*

This was tested by adding the 0·5 c.c. of the indicator solution to 100 c.c. of distilled water, and finding how much decinormal acid or alkali (1 c.c. = 0·0031 grm. Na_2O, or 0·004 grm. SO_3) was required to change the colour.

Litmus.—This indicator, as is well known, is naturally blue, and remains so in presence of alkalies and alkaline carbonates, but changes to red when a slight excess of acid is added. The litmus solution employed contained 20 grms. of the dry extract per litre. Half a c.c. of this was mixed with 100 c.c. of distilled water, and decinormal sulphuric acid added from a burette, drop by drop, till no further alteration in colour was observed. To accomplish this 0·5 c.c. of the acid was consumed. This is equal to 0·05 c.c. (about one drop) of normal acid, which is the strength usually employed in alkalimetric tests.

Methyl-orange.—This substance is soluble in water with formation of an orange-yellow liquid, which is unchanged in colour by alkalies or alkaline carbonates and bicarbonates, but is transformed to a deep pink by a mineral acid. The solution employed contained 0·15 grm. of the methyl-orange per litre, and 0·5 c.c. of decinormal acid was required to effect a complete change in the colour when tested in exactly the same way as the litmus solution. It is thus on an equality with litmus as regards delicacy in absence of all salts.

Phenacetolin.—This substance is soluble in alcohol with formation of a dark brown liquid, which gives, with the

* A Paper read before the Philosophical Society of Glasgow (Chemical Section), January 22, 1883.

hydrates of potassium and sodium, even in presence of carbonate, a scarcely perceptible yellow; with ammonia and the normal alkaline carbonates, a dark pink; with the bicarbonates, a much more intense pink than with the normal carbonates; an dwith mineral acids, a golden yellow colour. The solution employed contained 2 grms. of phenacetolin per litre, and was tested by decinormal carbonate of sodium, of which 0·1 c.c. was required to produce a decided change from a faint brown tinge to a dark pink.

Phenol-phthalein.—This indicator gives rise to a fine red colour in presence of alkaline hydrates and carbonates, but with bicarbonates (in absence of normal carbonates) and free acids no colour is produced. Phenol-phthalein is almost insoluble in water, but is readily soluble in 50 per cent alcohol. The solution used contained 0·5 grm. per litre, and was of a pale yellow colour, which was probably due to a slight impurity. When tested under the conditions observed in the case of the other indicators, 0·1 c.c. of decinormal hydrate of sodium caused a sudden transformation, the colourless solution becoming red. In the following table (I.) will be found a summary of the results given above:—

TABLE I.

Showing the delicacy of the indicators in the absence of interfering agents.

Amount of distilled water used for each test 100 c.c.
„ indicator solution „ „ 0·5 „

Name of Indicator.	Grms. of Solid Matter per Litre of Indicator Solution.	Amount of Decinormal Acid or Alkali required to change Colour of Indicator.
Litmus	20·0	0·5 c.c. H_2SO_4
Methyl-orange ..	0·15	0·5 „ „
Phenacetolin ..	2·0	0·1 „ Na_2CO_3
Phenol-phthalein	0·5	0·1 „ NaHO

II. *Application of the Indicators to the Determination of Soda existing as Hydrate, with a Small Proportion of Carbonate.*

The solution of caustic soda employed was of normal strength, and each test was made with 50 c.c., which thus contained 1·55 grms. of available soda. The soda existing as carbonate in this quantity was 0·024 grm., and was estimated by precipitation with chloride of barium.

Litmus.—When this indicator was used, exactly 50 c.c. of normal sulphuric acid were consumed. The solution was, of course, boiled thoroughly after each addition of acid, especially when near the neutral point, and only a single drop was required to effect the end-reaction.

Methyl-orange.—The great advantage claimed for methyl-orange over litmus is that with the former no boiling is required, as carbonic acid has no effect on the colour. On making several determinations of soda with this indicator, I found that its delicacy was by some means considerably impaired, as the pale yellow colour became just perceptibly tinged with pink when 49·95 c.c. of the normal acid were added. The change in colour was very decided when 50, but was not fully developed till 50·15 c.c. were consumed. In these cases 0·2 c.c. of the acid was necessary to bring out the full intensity of colour, while 0·05 c.c. produced the same result in absence of interfering agents. It would be naturally expected that if half the quantity of methyl-orange were used a proportionately more delicate end-reaction would be secured, but at least 0·15 c.c. of the normal acid was required to occasion the alteration in tint. Again, the same expectation might reasonably be entertained with regard to varying the proportions of soda, but I found that when 0·775 grm. of soda was tested 0·15 c.c., while with 3·1 grms. of soda 0·25 c.c., of the test acid was indispensable in effecting the complete transformation It is evident that this extension o. the end-reaction over from 0·15 to 0·25 c.c. of normal acid must be due, either to the liberated carbonic acid, or to the salt of sodium produced by the action of the acid on the hydrate and carbonate of sodium. That it is solely owing to the latter cause I shall show when the action of the neutral sulphates, chlorides, and nitrates of the alkalies is under consideration. On looking over these results the question arises,—At what point is the estimation of alkali, when methyl-orange is used as indicator, to be reckoned as finished? The point I have adopted is that at which the first *decided* change in colour is apparent, and this end-reaction coincides exactly with that of litmus. The intensification of the colour by the further addition of acid serves as a confirmation of the first reading. Greville Williams, in a paper which appeared in the CHEMICAL NEWS, vol. xxxix., p. 98, recommends for each determination the use of from 0·1 to 0·2 c.c. of a solution containing 0·1 grm. of methyl-orange per litre. The larger of these quantities is about one-fourth of that which I have employed, and when excess of acid is added gives a very faint pink colour, which is sensibly less intense in presence of much sulphate of sodium. It is obvious, however, that the amount of the indicator solution used must be varied according to the volume and colour (if any) of the solution in which the alkali is to be determined.

Phenacetolin.—This indicator was introduced by Degener for use in the determination of the respective proportions of hydrate and carbonate of sodium in the same solution, and was tested by Prof. Lunge, whose results will be found in the *Journ. Soc. Chem. Industry*, i., 55. To determine the hydrate of sodium the normal acid was added till the scarcely perceptible yellow colour gave place to a rose-pink, which remained permanent for a few minutes at least. Two tests gave respectively 49·1 and 49·2 c.c. of acid consumed, which are equal to 1·523 and 1·526 grms. of soda existing as hydrate, as against 1·526 obtained by deducting the soda existing as carbonate (which was determined by chloride of barium) from the total soda. It must be carefully borne in mind that the rose colour should be permanent, for it may be developed by adding a drop of the acid, even when there is still a little hydrate present, and then fade slowly away. The first reading can be confirmed by adding a drop or two more acid, which should render the colour more intense. To find the proportion of soda existing as carbonate, the addition of acid was now continued. The colour at first was intensified, then became mixed with yellow, and finally all the pink tinge was eliminated, and a golden yellow was produced. For each test 50 c.c. of the normal acid were consumed, thus giving, in the one case, 0·9 c.c. for the soda as carbonate, and in the other 0·8 c.c., showing respectively 0·027 and 0·024 grm. of soda existing as carbonate, as against 0·024 estimated by chloride of barium. A much sharper end-reaction is obtained by boiling off the carbonic acid after each addition of acid when determining the portion of soda existing as carbonate. Phenacetolin is not adapted to the estimation of small quantities of hydrate in presence of a large proportion of carbonate of sodium or potassium, as is evident from the following test:—To a solution containing 2·65 grms. of carbonate of sodium and 0·04 grm. of hydrate of sodium in 100 c.c., phenacetolin was added, but even after an hour had elapsed the dark pink colour did not disappear, as it should do if the process were of any value.

Phenol-phthalein.—This indicator, which seems first to have been employed by Luck in that capacity, can also be used for the determination of the proportion of hydrate and carbonate of sodium in the same sample. The method of procedure is to add the normal acid to the cold alkaline solution till the red colour is discharged, taking care, by using a dilute solution and keeping the point of the burette in the liquid, that no carbonic acid escapes. The point at which the colour is dispelled is when all the hydrate is neutralised, and the carbonate has been converted into bicarbonate according to the following equation:—

$$2Na_2CO_3 + H_2SO_4 = 2Na\,HCO_3 + Na_2SO_4.$$

By this means the whole of the soda existing as hydrate and half the soda as carbonate is determined. The number of c.c. consumed is now noted, and the estimation continued, boiling thoroughly after each addition of acid to decompose the bicarbonate of sodium, and thus bring back the red colour. It is preferable, as pointed out by Warder in his paper in the CHEMICAL NEWS, vol. xliii., p. 228, to add excess of normal acid, boil off the carbonic acid, and titrate back with normal caustic soda. The results of several experiments gave 49·6 c.c. of normal acid consumed for the hydrate and half the carbonate of sodium, and 50 c.c. for the total available soda, or, in other words, 0·8 c.c. for the carbonate and 49·2 for the hydrate. These results agree almost exactly with those obtained by the estimation of the carbonate of sodium by barium chloride, and with the use of phenacetolin as indicator. It must be noted that the more carbonate of sodium there is present, the less delicate will the end-reaction be, as the red colour gradually fades away during the first portion of the titration. It is also evident, from the nature of the process, that this method is quite unreliable for the determination of a small quantity of hydrate of sodium in presence of a large proportion of carbonate of sodium.

TABLE II.

Showing results obtained by each indicator when used in the determination of soda in caustic soda containing a little carbonate of sodium.

Soda, existing as hydrate, employed .. 1·526 grms.
" " carbonate, " .. 0·024 "
Total soda employed .. .. 1·550 "

Name of Indicator.	Grms. of Total Na_2O found.	Grms. of Na_2O as Hydrate found.	Grms. of Na_2O as Carbonate found.
Litmus	1·55—1·55	—	—
Methyl-orange	1·55—1·55	—	—
Phenacetolin..	1·55—1·55	1·523—1·526	0·027—0·024
Phenol-phthalein—	1·55—1·55	1·526—1·526	0·024—0·024

III. *Estimation of Available Potash in Caustic Potash.*

It is quite unnecessary for me to give any details of the results of the experiments made under this head. Litmus and methyl-orange can be used for the determination of the total available potash and phenacetolin and phenol-phthalein for the estimation of the respective proportions of hydrate and carbonate of potassium, with as great accuracy as in the case of the caustic soda.

IV. *Estimation of Ammonia existing as Hydrate.*

The liquor ammonia used for the following tests did not contain an appreciable quality of carbonate, and was free from other impurities. It was diluted with an indefinite quantity of water, and 50 c.c. of the dilute sample were employed for each determination. This quantity, according to a result obtained by converting the ammonia into chloride of ammonium and drying at 100° C., contained 0·547 grm. of ammonia (NH_3).

When litmus, methyl-orange, or phenacetolin was used, exactly 32·4 c.c. of normal sulphuric acid was consumed, which are equal to 0·550 grm. of ammonia. The end-reactions in each case were quite as delicate as with caustic soda. As phenacetolin produces with ammonia the dark pink colour characteristic of its reaction with the carbonates of sodium and potassium, and not the faint yellow found with the hydrates of these metals, the respective proportions of hydrate and carbonate of ammonium cannot be determined by titration in presence of this indicator.

In the two determinations made with phenol-phthalein as indicator 31·5 c.c. and 31·4 c.c. of the normal acid were consumed. After 25 c.c. had been added the colour began to fade away slowly, and was fully discharged at the point mentioned. These results show respectively 0·535 and 0·533 grm. of ammonia, and are so far below the truth as to be equal to about 3 per cent of the whole ammonia present. It is therefore perfectly plain that phenol-phthalein is utterly useless for indicating the end-reaction in the estimation of ammonia. This anomalous behaviour of phenol-phthalein is due to the action of the salt of ammonium which is formed, and which destroys the red colour produced by the ammonia when the proportion of the latter becomes small. That this is the true explanation will be shown when the effect of the neutral salts of ammonium on the indicators comes to be examined.

TABLE III.

Determination of Ammonia existing as Hydrate. Ammonia (NH_3) *employed for each test*, 0·547 *grm.*

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of NH_3 obtained
Litmus	32·4	0·550
Methyl-orange ..	32·4	0·550
Phenacetolin.. ..	32·4	0·550
Phenol-phthalein..	31·5—31·4	0·535—0·533

Before writing the above I had not met with any mention of phenol-phthalein as an indicator for the estimation of ammonia; but quite recently it has been recommended for this purpose by Richter in a paper on a "New Volumetric Determination of Potassium Bichromate, and its Use as a Standard for Caustic Alkalies." (See CHEMICAL NEWS, vol. xlvii., p. 19.) The process he has devised may be thus briefly described:—To the caustic soda, potash, or ammonia solution, which has been previously coloured with phenol-phthalein, add standard dichromate of potassium till the reddish yellow colour produced is changed to a full yellow. At this point the alkali is neutralised, a monochromate of the alkali or alkalies is formed, and the reddish tinge due to the presence of the phenol-phthalein in the alkaline solution is discharged when the least excess of acid chromate is consumed. The quantities advised for use are such that the solution in which the titration has been accomplished should measure 150 or 200 c.c., and contain about 1 grm. of the monochromate of potassium. A solution of this salt of the strength mentioned is to be used as a comparison in deciding at what point the end-reaction occurs. Following these instructions as closely as possible, I prepared a decinormal solution of potassium bichromate (14·76 grms. per litre), and also decinormal solutions of caustic soda, potash, and ammonia, the alkali liquors being tested against decinormal sulphuric acid. 50 c.c. of the soda solution was transferred to a beaker, diluted with 50 c.c. of water, coloured with phenol-phthalein, and the decinormal bichromate solution added from a burette. The fine red tint soon changed to reddish yellow, which lost little or none of its intensity till it nearly reached the neutral point. The end-reaction was thus easily observed, especially when compared with the solution of monochromate of potassium of nearly the same strength as that operated upon. It must be carefully noted, however, that the change in colour is not instantaneous, as it is by titration with a mineral acid, so that when the test is nearly finished a minute or two must be allowed to pass after each addition, before coming to any conclusion as to whether the end-reaction has taken place, otherwise a high result will be the consequence. The results of two tests were that 50 and 50·1 c.c. of the decinormal bichromate were consumed, which are as near the truth as possible.

With regard to the determination of the potash, it is sufficient to mention that the results were substantially the same as those obtained with soda.

In estimating the ammonia in 50 c.c. of the decinormal solution of ammonia, the addition of the bichromate produced at first the reddish yellow colour, which slowly disappeared on further addition, and gave place to the full yellow when 45·7 c.c. had been consumed in the one case and 46 c.c. in the other. This gives a result so much below the truth as to be equivalent to 8 per cent of the whole ammonia present. From these results it is quite

plain that Richter had not tested ammonia specially with phenol-phthalein as indicator, but has simply assumed that it would act in precisely the same manner as potash and soda.

TABLE IV.

Comparison of results obtained in the estimation of alkalies by Richter's bichromate and the ordinary acid methods, phenol-phthalein being the indicator.

Amount of soda used for each test .. 0·1550 grm.
,, potash ,, ,, .. 0·2355 ,,
,, ammonia ,, ,, .. 0·0850 ,,

Name of Alkali determined.	C.c. of N/10 $K_2Cr_2O_7$ consumed.	Grm. of Alkali obtained.	C.c. of N/10 Acid consumed.	Grm. of Alkali obtained.
Soda (Na_2O) ..	50·1	0·1553	50·1	0·1553
ditto ..	50·0	0·1550	50·1	0·1553
Potash (K_2O) ..	50·1	0·2359	50·1	0·2359
ditto ..	50·2	0·2363	50·0	0·2355
Ammonia (NH_3)	46·0	0·0782	47·1	0·0800
ditto ..	45·7	0·0777	46·9	0·0797

V. *Determination of Alkalies Existing as Carbonate and Bicarbonate.*

It is not worth while going fully into the results of the tests made on this part of the subject. As almost all the noteworthy points have been already mentioned, I will just note a few necessary precautions. As is well known, litmus can be used in the direct estimation of soda and potash existing as carbonate or bicarbonate by an acid, but can only be applied to the determination of ammonia in that form when excess of acid is added, the solution boiled to expel carbonic acid, and titrated back with an alkali. The same remarks apply to phenacetolin.

Methyl-orange can be employed equally well in the estimation of alkali in any of the alkaline carbonates, but special mention may be made of its application to the determination of ammonia in the commercial carbonate. This substance is a compound of bicarbonate and carbamate of ammonium, and when dissolved in water the latter of these salts takes up the elements of water and produces normal carbonate of ammonium. The sample tested did not contain any impurities except water, and 2·5 grms. converted into chloride and dried at 100° C. showed 0·725 grm. of ammonia, while two experiments made with 2·5 grms., which consumed 43·1 and 43·05 c.c. of normal sulphuric acid, gave respectively 0·732 and 0·731 grm. of ammonia.

Phenol-phthalein, as stated before, cannot be used for the estimation of ammonia, and in the determination of soda and potash existing as carbonate or bicarbonate (the latter giving no colour with this indicator till decomposed by boiling), a somewhat tedious boiling is required unless excess of acid be added, the solution boiled, and titrated back with caustic soda.

VI. *Behaviour of the Indicators with the Sulphates, Nitrates, and Chlorides of the Alkalies.*

Having considered the use of the indicators for the estimation of the alkalies when pure compounds are operated upon, we now come to the behaviour of the indicators with the common impurities present in commercial samples. This section, however, is chiefly concerned with the action (if any) of the neutral salts produced during titration. Litmus and phenacetolin are quite as delicate in presence of quantities of the sulphates, nitrates, and chlorides of sodium, potassium, and ammonium, equivalent to 1·55 grms. of soda (Na_2O) per 100 c.c. When these amounts of these salts were tested with the volume of methyl-orange solution used in the foregoing experiments, it was found, as has been already stated, that about 0·2 c.c. of normal acid was required to bring out the full pink colour, as against 0·05 c.c. when distilled water only was employed, although a distinct change was produced with 0·05 c.c. in the former case. On the other hand, the delicacy of phenol-phthalein is not affected by the salts of sodium and potassium mentioned above, but quantities of sulphate, nitrate, and chloride of ammonium, equivalent to 0·85 grm. of ammonia per 100 c.c., required about 1·5 c.c. of normal caustic soda to produce even the faintest red colour, showing that ammonia and its salts must be carefully excluded when this indicator is made use of.

VII. *Effect of the Sulphites of the Alkalies.*

A sample of ordinary normal sulphite of sodium was selected, tested for impurities, and the sulphurous acid, sulphuric acid, and soda, determined, to make certain that it was of the proper composition. This was found to be the case, and a solution was prepared, of which 50 c.c. (the amount used for each test) contained 3·15 grms. of sulphite of sodium. This is equal to 1·55 grms. of soda (Na_2O).

Litmus.—On adding the normal acid to the portion tested with this indicator, the solution remained quite blue till about 12 c.c. had been added, but after that it became purple, and slowly passed into the red. The end-reaction was observed by comparing with a solution containing the same quantity of litmus reddened. 24·9 c.c. were consumed, which is equal to 0·772 grm. of soda, or very nearly half that contained in the sulphite of sodium. When boiled the colouring matter is destroyed.

Methyl-orange.—In this case 25·1 c.c. of the normal acid were consumed, which is equal to 0·778 grm. of soda, a result slightly higher than that obtained by litmus, but still practically the same. The end-reaction was unlike that of litmus—very sharp and decided.

Phenacetolin.—With phenacetolin the result was exactly the same as that procured with methyl-orange, but, as in the case of litmus, the colour changed so gradually that the end-reaction was not very sharply defined.

Phenol-phthalein.—Sulphite of sodium is practically neutral to phenol-phthalein, but, as has been shown, it is strongly alkaline to the other three indicators. Only 0·2 c.c. of normal acid was necessary to discharge the red colour in the cold, but when boiled 4 c.c. were required. On cooling and titrating back, 3·8 c.c. of normal alkali were consumed, so that when this method is employed the practical neutrality of sulphite of sodium may be depended upon, provided too much acid is not added before boiling. If a large excess of acid were used the boiling would expel sulphurous acid, and a high result would be the consequence. It need only be added that potassium and ammonium sulphite act towards these indicators in the same way as the sodium compound, except in the case of the ammonium salt with phenol-phthalein, which cannot be used in presence of ammonium compounds.

TABLE V.

Results obtained in the titration of sodium sulphite with normal acid.

Amount of Na_2SO_3 used for each test .. 3·15 grms.
Equal to Na_2O ,, ,, ,, .. 1·55 ,,

Name of Indicator.	C.c. of Normal Acid consumed.	Grms. of Na_2O obtained.
Litmus	24·9	0·772
Methyl-orange	25·1	0·778
Phenacetolin	25·1	0·778
Phenol phthalein (cold).	0·2	0·006
,, (boiled)	4·0	0·124

VIII. *Effect of Thiosulphate of Sodium.*

This salt, which is known better as hyposulphite of soda, is perfectly neutral to litmus, methyl-orange, phenacetolin, and phenol-phthalein.

IX. *Effect of Sulphide of Sodium.*

To obtain pure normal sulphide of sodium, a solution of sulphuretted hydrogen was prepared, the strength of which was determined by oxidation in an alkaline solution with peroxide of hydrogen and precipitation with chloride of

barium. Exactly enough hydrate of sodium was now added to form Na_2S, and the solution made up to such a volume that 50 c.c. (the quantity operated upon) contained 0·284 grm. of the sulphide.

Litmus.—When thoroughly boiled after each addition of acid to expel the sulphuretted hydrogen an excellent result was obtained, 7·2 c.c. of normal acid being consumed. This is equal to 0·280 grm. of sulphide of sodium.

Methyl-orange.—With this indicator the same number of c.c. of acid was consumed as with litmus. The liberated sulphuretted hydrogen had evidently no effect on the colour, as the end-reaction was quite sharp. This has been pointed out by Lunge. Phenacetolin behaves in much the same way as litmus, the boiling off of the sulphuretted hydrogen being necessary to the obtaining of a decided change in colour when the end of the experiment is reached. The result was the same as that obtained with litmus.

Phenol-phthalein gave rise to the characteristic red colour with the sulphide of sodium, but the colour was discharged after the addition of 3·55 c.c. of normal sulphuric acid. This is practically equal to half of the sodium sulphide, and shows that the sodium hydrogen sulphide, which is formed by the combination of the normal sulphide with the liberated sulphuretted hydrogen, is neutral to phenol-phthalein. On boiling the solution the red colour returned, and altogether 7·15 c.c. of the acid were consumed, the whole of the sodium sulphide being thus estimated.

Potassium and ammonium sulphides have exactly the same effect as the sodium compound, always excluding phenol-phthalein with regard to the ammonium salt.

TABLE VI.

Results obtained in the titration of sodium sulphide by normal acid.

Amount of Na_2S employed for each test.. 0·284 grm.

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of Na_2S found.
Litmus..	7·2	0·280
Methyl-orange	7·2	0·280
Phenacetolin	7·2	0·280
Phenol-phthalein (cold)	3·55	0·138
,, (boiled)	7·15	0·278

X. *Effect of the Phosphates of the Alkalies.*

As the normal phosphate of potassium is generally found to the extent of 1 or 2 per cent (it has even been found as high as 7 per cent) in commercial carbonate of potash, it is a matter of great importance to know what proportion of the potash existing as phosphate is determined by standard acid. I found that the phosphates of potassium, sodium, and ammonium acted in the same manner towards the indicators when titrated with standard acid, and will therefore only quote the double series of experiments made, the one with normal sodium orthophosphate (Na_3PO_4), and the other with the ordinary disodium hydrogen ortho-phosphate (Na_2HPO_4). The crystallised form of the former of these salts was prepared by dissolving a weighed quantity of the latter in boiling water, adding the proper proportion of hydrate of sodium, and allowing to crystallise out. After re-crystallising both of these phosphates, a portion of each was ignited to obtain the real amount of dry salt in each, and solutions made of such a strength that 50 c.c. contained, in the one case, 2·05 grms. Na_3PO_4 (equal to 1·162 grms. Na_2O), and in the other 1·775 grms. Na_2HPO_4 (equal to 0·775 grm. of Na_2O).

When *Litmus* was used in the titration of the normal phosphate, the blue colour remained intact until about 16 c.c. of the normal sulphuric acid were added, when it became purple, and on further addition slowly passed into red, the change being complete at about 24·9 c.c. This is equal to 0·772 grm. of soda, which is practically two-thirds of the total soda. The point at which the red colour was fully developed could not be ascertained with any degree of accuracy, even when a solution of reddened litmus was used for comparison, as the change was so very gradual. The mono-acid phosphate consumed 12·4 c.c. of the standard acid, thus agreeing with the result of the normal phosphate.

Methyl-orange gives as delicate an end-reaction as with hydrate of sodium. The results were slightly higher, and nearer the truth than those obtained with litmus, 25·05 c.c. being required in the one case, and 12·6 in the other.

Phenacetolin.—With this indicator the same number of c.c. were necessary as with litmus, and, like the latter, it changes gradually in colour, so that the point at which excess of acid is added is somewhat difficult to catch. There is, however, a peculiar phenomenon to be noticed with regard to this indicator. The normal phosphate, like hydrate of sodium, only brings out the scarcely perceptible yellow colour, but after the addition of about 11 c.c. of the normal acid, the permanent pink colour is formed. In fact, the first-named salt acts towards phenacetolin as if it were a mixture of hydrate and the mono-acid phosphate of sodium. The latter salt produces the pink colour at once.

Phenol-phthalein, again, acts in an entirely different way to the other indicators. We have seen before that $NaHCO_3$, NaHS, and Na_2SO_3 are neutral to this indicator, and to these must now be added Na_2HPO_4, while $NaHSO_3$ and NaH_2PO_4 are neutral to litmus, methyl-orange, and phenacetolin, $NaHCO_3$ and NaHS being alkaline, and not requiring to be decomposed by boiling before determining the alkali in them by test acid. It will be observed that in each case there is exactly an atom of sodium of difference, the phenol-phthalein being invariably the weaker indicator.

In titrating the normal phosphate 12·65 c.c. of the test acid were required to discharge the red colour in the cold, and 13·7 c.c. in the boiling solution, the mono-acid phosphate requiring only 0·25 in the cold, and 1·4 in the hot. In each case, on cooling and titrating back with caustic soda, the same result as was obtained at first in the cold solution was brought out. These results show that when phenol-phthalein is employed, one-third of the soda in normal phosphate of sodium is estimated by standard sulphuric acid, and only a trifling portion of that existing as the mono-acid phosphate.

TABLE VII.

Results obtained in the titration of normal sodium phosphate and disodium hydrogen phosphate by normal acid.

Na_3PO_4 used for each test .. .. 2·050
$= Na_2O$,, ,, ,, ... 1·162
Na_2HPO_4 ,, ,, ,, ... 1·775
$= Na_2O$,, ,, ,, ... 0·775

Name of Indicator.	Na_3PO_4. C.c. Normal Acid consumed.	Na_3PO_4. Grm. of Na_2O found.	Na_2HPO_4. C.c. Normal Acid consumed.	Na_2HPO_4. Grm. of Na_2O found.
Litmus	24·9	0·772	12·4	0·384
Methyl-orange	25·05	0·776	12·6	0·390
Phenacetolin (1st change)—	11·0	0·341	—	—
,, (2nd change)—	24·9	0·772	12·4	0·384
Phenol-phthalein (cold)—	12·65	0·392	0·25	0·008
,, (boiled)—	13·7	0·425	1·4	0·043

(To be continued.)

Researches on Mesitylene.—G. Robinet.—The author has obtained mono- and di-chloride, di-bromide mesitylenic acid, dimethyl-phenylacetic acid, and mesitylene picrate.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, March 10th, 1883.

Professor G. C. Foster in the Chair.

New Member:—Major W. S. Boileau.

Mr. Shelford Bidwell read a paper "*On a New Method of Measuring Resistances with Constant Currents.*" It consists in placing a resistance box in the arm of the bridge, which afterwards has to contain the unknown resistance. A balance is effected by unplugging resistance in this box. The unknown resistance is then inserted in the same arm, and the balance restored by plugging resistance out of the box. The amount plugged out equals the unknown resistance.

Prof. F. Guthrie made a communication on "*Liquid Slabs.*" Films of liquid spread out like a flattened drop on a solid surface are found by the author to have a thickness which is a physical constant for the same liquid, provided the area is very great in proportion to the thickness. Sodium amalgam inserted in a mercury slab causes it to spread out further. Prof. Guthrie also finds that an electric current increases the diffusion of sodium amalgam through mercury in the direction of the current.

Mr. Baily suggested that as the diffusion produces a current an opposing current might be found to stop the diffusion.

Mr. Stanley said the largest water drop he had measured was one-fifth of an inch.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

January 22, 1883.

Mr. Robert R. Tatlock, F.C.S., President, in the Chair.

A meeting of this Section was held within the Society's Rooms, 207, Bath Street, on the above evening.

After the usual preliminary business had been transacted Mr. Robert T. Thomson read a paper "*On the Use of Litmus, Methyl-orange, Phenacetolin, and Phenol-phthalein as Indicators*" (see p. 123).

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 7, February 12, 1883.

Researches on the Chromates.—M. Berthelot.—A thermo-chemical paper treating of the solution heat of potassium and ammonium bichromates and of chlorochromic acid, the heat of the neutralisation of chromic acid by potassa and ammonia, and the reaction of acids with the chromates.

The Theory and the Experiments of Mercadier and Waschy tending to Establish the Non-Influence of the Di-electric upon Electro-dynamic Actions.—Maurice Lévy.—A mathematical paper, not adapted for abstraction.

General Method for Reinforcing Telephonic Currents.—James Moser.—The author constructs a battery of telephones by which he can give to the current any desired strength.

Lead and Ammonium Chlorides and Lead Oxy-Chlorides.—G. André.—The author has obtained a certain number of double chlorides of lead and ammonium by dissolving in heat pulverised lead chloride in solutions of ammonium chloride, saturated first in cold, and then in heat.

Preparation of Ethers of Trichloracetic Acid.—A. Clermont.—The author mixes equivalent proportions of alcohol and of crystalline trichloracetic acid, adds the quantity of monohydrated sulphuric acid indicated by theory for the formation of its bihydrate. The mixture becomes turbid, and on adding a suitable quantity of water, trichloracetic acid settles to the bottom of the vessel.

Contribution to the Study of Isomerism in the Pyridic Series.—Œchsner de Coninck.—The author has succeeded in demonstrating the existence of two isomeric lutidines in the crude quinoleine derived from brucine.

Relative Toxic Power of Metallic Salts.—Dr. J. Blake.—The author shows that the toxic power of the metals does not, as is maintained by M. Rabuteau, follow in the regular series of their atomic weights, but that this order can only be traced in the isomorphous groups.

No. 8, February 19, 1883.

Results of the Experiments made by M. Deprez in the Laboratory of the Northern Railway of France on the Electric Transportation of Work to Great Distances.—M. Tresca.—The work really transmitted to the distance of 8½ kilometres by an ordinary telegraphic wire of 4 m.m. in diameter, arranged on the method of M. Deprez, represents one-third of the moving work. If, whilst the currents remain the same, we leave out of view the resistance of the intermediate circuit, the corresponding useful effect may rise to nearly the half of the motor work.

Report on a Memoir by M. Rosenstiehl, entitled "Researches on the Colouring-Matters of Madder."—A. Wurtz.—The author, after giving a very full account of successive discoveries concerning the colouring principles of madder, summarises M. Rosenstiehl's results. The latter shows that madder, apparently so complicated, contains in reality only three glucosides: that which yields pseudo-purpurine or carboxyl-purpuric acid, that which yields carboxyl-alizaric acid, and that which yields munjistine, or carboxyl-xantho-purpuric acid.

Crystals observed in the Interior of a Bar of Swedish Iron after Cementation.—L. Stoltzer.—In a bar, which had been placed in the hottest part of the furnace, there were remarked blisters occupied by regular octahedral crystals.

Proximate Analysis of Pozzolanas, and a Rapid Method of Testing their Hydraulic Value.—E. Landrin.—The author shows that the silica liberated from these bodies is a hydraulic silica in its most efficient state. The method proposed for the test is treatment with hydrochloric acid, removal of the soluble portion by filtration, and washing, and treatment of the insoluble portion with lime water. The more lime it withdraws from solution, the better is the quality of the cement.

Sulpho-cyano-propimine.—J Tcherniac and T. H. Norton.—The authors have obtained and examined the sulpho-cyanate, nitrate, and chloro-platinate of sulpho-cyano-propimine, its acetyl-compound, and its hydriodate.

Allotropic Arsenic.—R. Engel.—The author concludes that arsenic exists in two distinct states. Whenever it is isolated, either by the moist or the dry way, below 360°, it is amorphous, dark grey, brown or black, and not affected by moist air. Its specific gravity is from 4·6 to 4·7. If heated to 360° it is converted into the other modification, of sp. gr. 5·7. Nitric acid attacks it more or less readily according to its state of division. This variety, commonly met with in laboratories, crystallises when it is formed by the condensation of its vapour about or above 360°.

The Vision of the Ultra-Violet Radiations.—M. de Chardonnet.—The author asks what becomes of the ultra-violet rays absorbed by the media of the human eye, and what form is taken by the energy thus transformed? It is probable that this transformation does not take place without fatigue to the organ, especially in case of the long and brilliant ultra-solar spectrum of the electric arc. On the other hand the spectrum of the incandescence-light does not go far beyond the visible spectrum. Hence this light saves the eye from the labour of absorbing and transforming the ultra-violet rays.

Journal für Praktische Chemie.
New Series, Vol. xxvi, Part 9, No. 20, 1882.

Researches on the Aluminates and the Basic Haloid Salts of Barium, and Notes on Barium Hydrate and the Haloid Salts of Barium.—Dr. Ernst Beckmann.—The author remarks that not merely sodium aluminate but barium aluminate is finding extensive application in dyeing, printing, and sugar making. He first examines the behaviour of aluminium hydroxide, aluminium chloride, and aluminium with solution of baryta, and of aluminium barium with water. With the hydrate baryta water forms at first a soluble compound of the composition $Al_2O_3BaO.aq$. If this solution is heated for a length of time with an excess of aluminium hydroxide, there is formed some insoluble aluminate. The hydrate is rendered less soluble by prolonged contact with water at common temperatures. If baryta water is added to solution of aluminium chloride, there is formed a precipitate of alumina, containing mere traces of baryta, whilst barium chloride remains in solution. Metallic aluminium is briskly attacked by baryta water, whilst aluminium hydroxide is deposited as a powder. The author then describes the compounds of aluminium and barium at some length.

Behaviour of the Conglutine from Lupin Seeds with Saline Solutions.—H. Ritthausen.—Lupins contain two proteines, conglutine and legumine, the former in much larger proportion than the latter. They are best separated by dissolving both together in water containing potassa, allowing the solution to stand for some time in the cold, precipitating with hydrochloric or acetic acid, drying the precipitate over sulphuric acid, and treating it with a 5 per cent solution of common salt. Conglutine dissolves and legumine remains insoluble.

Albumenoids of Peach-Kernels and the Press-cake of Sesame Seeds.—H. Ritthausen.—The body obtained from peach-kernels closely agrees with the conglutine of lupins. The albumenoid of sesame cake contains less sulphur than the author obtained in some former experiments.

Nitrophenyl-Ethers of Tribasic Formic Acid.—A. Weddige.—An account of the ortho- and para-compounds.

Preparation of Chloro-carbonic Methyl-ether.—A. Klepl.—The author passes purified chloro-carbonic oxide into diluted methylic alcohol.

Parts 10 and 11.

Meconic Acid and certain of its Derivatives.—Ernst Memel.—The author describes the mono-, di-, and tri-ethyl-ethers of meconic acid, ethyl-meconic acid with its lead salt, ethyl-comenic acid and its silver salt; the action of ammonia upon mono-ether-meconic acid, mono-meconaminic acid; the action of bromine upon meconic acid and its ethers, brom-oxyl-brom-komenic acid, and brom-oxyl-brom-komenic ether. He concludes from his experiments that meconic acid is a dibasic oxy-acid, for which view the tri-ethyl-ether and its derivatives, ethyl-meconic and ethyl-comenic acids, supply a proof. The hydroxyl of meconic acid is comparable to phenol-hydroxyl. Consequently the silver salt regarded by Liebig as neutral is in its composition analogous to the so-called basic sodium salicylate. The compounds which in watery solution have a neutral reaction and have hitherto been termed mono-acid, are true neutral salts of meconic acid.

Researches on the Aluminates and the Basic Haloid Salts of Barium, with Notes on Barium Hydroxide and the Haloid Salts of Barium.—Dr. Ernst Beckmann.—The author here studies the compounds of alumina with barium chloride; those with barium bromide; with the corresponding iodide; the compounds with barium nitrate, and acetate.

Communications from the Chemico-Agricultural Laboratory of the University of Königsberg.—H. Ritthausen.—These consist of an account of the behaviour of legumine with saline solutions. The seeds in which legumine is present contain it as a substance soluble in saline liquids, but capable of being converted by alkaline liquids containing free alkaline hydrate into the insoluble modification, without decomposition.

Bulletin de la Société Chimique de Paris.
No. 1, January 5, 1883.

Studies on the Combustion of Explosive Gaseous Mixtures.—MM. Mallard and Le Chatelier.—This paper has been already noticed under the *Comptes Rendus*.

Researches on the Passage of Alcoholic Liquids through Membranes.—H. Gal.—Already noticed.

Isomorphism of Mass.—D. Klein.—Already noticed.

Method of Converting Tricalcic Phosphate into the Phosphorus Chlorides.—J. Riban.—The author passes chlorine and carbon monoxide over a mixture of charcoal and tricalcic phosphate at a temperature of 180°. The products are phosphorus oxy-chloride, calcium chloride, and carbonic acid.

Isomeric States of the Haloid Salts.—M. Berthelot.

Double Decompositions of the Haloid Salts of Silver.—M. Berthelot.

Researches on Lead Iodide.—M. Berthelot.—These three thermo-chemical papers have been already noticed.

No. 2, January 20, 1883.

Butyric Ferment of Arable Soil.—P. Dehérain and L. Maquenne.

Double Salts prepared by Fusion.—MM. Berthelot and Ilosvay.

Reciprocal Displacements of Halogenous Bodies and the Secondary Compounds which Preside in it.—M. Berthelot.—These three papers have been already noticed.

Swedish Correspondence.—P. T. Clève.—Including:—

α-Chlorated Naphthyl Sulphurous Acid.—K. E. Arnell.—The author determines the constitution of α-chlorated naphthyl sulphurous acid, and of the corresponding bromine compound.

Nitro-Derivatives of the Naphthyl Disulphurous Acids.—I. E. Alen.—An account of the mono-nitro- and dinitro-compounds.

Journal de Pharmacie et de Chimie.
Tome vii., February, 1883.

Pneumo-enteritis of Swine.—M. Pasteur.—This paper has no chemical interest.

Extraction of the Colouring-Matters of Blue Urine, Indigotine, and Indirubine.—C. Méhu.—The author renders the urine in question distinctly acid by the addition of a few drops of sulphuric acid, and then saturates it with ammonium sulphate as a dry powder. The pigments urobiline, bilirubine, biliverdine, &c., are immediately separated. The liquid is filtered, the precipitate washed with a small quantity of a saturated solution of

ammonium sulphate. To obtain the whole of the blue (indigotine) and red (indirubine) of violet or blue urine it is sufficient to proceed as already indicated, adding the sulphuric acid drop by drop, so as to leave about 1 grm. of free sulphuric acid per kilo. of liquid. Ammonium sulphate is then added in large excess. The precipitate and filter are washed as before with a saturated solution of ammonium sulphate slightly acidified with sulphuric acid. The dry filtrate is of a violet colour, and retains ammonium sulphate, sometimes albumen, urates, various histological elements, and lastly the small trace of the blue and red colouring-matters. The indirubine is dissolved out by treating the dry filter with alcohol at 50 per cent. Solvents appear to act differently upon the indigotine from indigo and the indigo from urine.

Possible Purification of Denaturised Alcohol.—MM. P. Cazeneuve and Chapuis.—By means of hydrogenisation the acetone present in methylated spirit can be almost entirely destroyed in about twenty days.

A Case of Physical Isomerism of Camphor Monochloride.—P. Cazeneuve.—Already noticed.

Properties of Invertine.—E. Bourquelot.—Invertine has not a saccharifying action upon starch-paste.

Experimental Researches upon the Appearance of Phosphoric Acid in Urine.—Léon Eymonnet.

Researches on the Elimination of the Hypophosphites by the Urine.—L. Eymonnet.—These two papers are more of a medical than a chemical character.

Organisms Developed in Phenic Solutions.—Dr. Fessinger.—Aërobic vibrios are able to vegetate in phenic solutions, whilst the anaërobic forms are excluded.

Justus Liebig's Annalen der Chemie,
Band 216, Hefts 1 and 2.

Researches on Uranium (Second Memoir).—Clemens Zimmermann.—The author determines the vapour-density of uranium bromide and chloride, for the former of which he finds the mean value 19·46, and for the latter 13·21; these figures approximate closely to those found by calculation on the assumption that Ur = 240. The specific gravity of metallic uranium in the fused state, referred to water at 4° and to a vacuum, is 18·685. The atomic volume of uranium is 12·84, and its specific heat 0·02765. The author's results fully confirm the conclusions of Mendelejeff that the atomic weight of uranium = 240, and that it must rank with chromium, molybdenum, and tungsten in the sixth group of the periodic system. The memoir includes an account of the chief reactions of the uranous salts, and of the properties of metallic molybdenum.

Communications from the Chemical Institute of the University of Strassburg.—These consist of researches on the non-saturated acids, conducted under the superintendence of Professor Rudolph Fittig, and including papers: on two new Caprolactones, by Leo Gottstein; on a new hepto- and octo-lactone, by Sidney Young; on a peculiar decomposition of the substituted acetyl-acetic ethers, by the same chemist; on the lactones from allyl-malonic acid, diallyl-malonic acid, and diallyl-acetic acid, by Ed. v. Hjelt; on itamalic acid, para-conic acid, and aconic acid, by Alexander Beer; on phenyl-butyro-lactone and phenyl-paraconic acid, by H. W. Jayne; on phenyl-oxy-pivalic acid, by Rud. Fittig and H. W. Jayne; on phenyl-homo-paraconic acid, by S. L. Penfield; on the delta-lactone of the normal capronic acid, by L. Wolff; on cumarine, by G. Ebert; on cumarilic acid, by R. Fittig and G. Ebert; on hydropiperic acid and piperhydronic acid, by Eugen Buri; and on the action of sulphuric acid upon cinnamic acid with the aid of heat, by Ernst Erdmann.

Communications from the Laboratory of the University of Göttingen.—These comprise memoirs by Rud. Gissmann on the behaviour of durol with chromic acid, and on dinitro-durylic acid; by H. Aschenbrandt on para-diethyl-benzol, and by H. Körner on para-dinormal-propyl-benzol.

On Hæmatoxyleine and Hæmateine.—E. Erdmann and G. Shultz.—The hard crystalline deposit adhering to vats in which extract of logwood had been kept was ground up with water to a paste and extracted in large bottles with much ether. The ethereal extract was drawn off when clear; the ether distilled off, and the syrupy extract mixed with hot water. The hæmatoxyleine crystallises out and may be purified by re-crystallisation. From dilute solutions are obtained columnar, often hollow needles containing 3 aq; but from more concentrated solutions rhombic tables with 1 aq. From the mother-liquors, on concentration, there are sometimes deposited shining leaflets of hæmateine—a proof that this product exists pre-formed in the raw material. The authors saw no reason to question Gerhardt's formula $C_{16}H_{14}O_6$. They consider that it contains only five hydroxyl-groups. The authors find that the yield and purity of hæmateine are greatly influenced by the duration of the process. It is best to pour the ammoniacal solution of hæmatoxyline into roomy, shallow glass capsules, so as to afford the largest possible surface; to keep up a constant small excess of ammonia by the occasional addition of a few drops, and to take from time to time small samples and mix them with acetic acid in a test-tube. As soon as a precipitate appears immediately, or after a short time, and on boiling is converted into crystalline scales, the experiment is stopped, the whole product is heated to boiling in a flask and neutralised with acetic acid. The composition of hæmateine is expressed by $C_{16}H_{12}O_6$. The authors, in opposition to Benedict, find no trace of nitrogen in hæmateine. Hæmateine is scarcely soluble in boiling water. It dissolves freely in hydrochloric acid, and crystallises out in small, dark-red needles. In sulphuric acid it dissolves also to a red liquid, which, on mixture with water, deposits a red powder, not stable if filtered off. It re-dissolves on the application of heat, unless an excess of water is present, and on cooling crystallises in needles. Sulphurous acid, and especially alkaline bisulphites, quickly dissolve hæmateine in great quantity, forming an almost colourless solution. There is, however, here, no reduction to hæmatoxyline. There are formed very soluble addition products; that with sulphurous acid is partially decomposed by boiling, whilst that with sodium bisulphite is decomposed on heating with an acid, and deposits hæmateine. The authors could not by any method succeed in re-producing hæmatoxyline from *this* hæmateine. Reim, however, obtained from hæmatoxyline another oxidation-product which he, indeed, considers identical with Erdmann's hæmateine, but which, though possessing the same percentage composition, are totally different in their behaviour. Reim's derivative appears in the form of brownish-red needles, which dissolve in boiling water much more freely than Erdmann's hæmateine. The solution in sulphuric acid does not give a red precipitate when mixed with water. Above all, Reim's product is at once reduced to hæmatoxyline on boiling with sulphurous acid. Meyer's observation that hæmatoxyline, when submitted to dry distillation, yields a mixture of resorcine and pyrogallic acid, was decidedly confirmed. The two compounds may be approximately separated by extraction with boiling benzol, in which pyrogallic acid is more readily soluble.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 1.

Experimental Researches on the Particular Influences of the Elements of Arable Soil upon the Evaporation of Water.—F. Masure.—The author views soils as essentially composed of four materials, sand, whether siliceous, calcareous, or felspathic, pulverulent

limestone, clay, and humoid matter formed from the decomposition of dung and organic matter in general. He examines the capacity of saturation of these ingredients, the rate at which they dry, their permeability, density, hygroscopic power, condensing power, power of becoming heated by the sun's rays, of becoming aërated, and nightly cooling. From these results he draws conclusions as to the cultivation of sandy, calcareous, and clayey soils. He calls attention to certain physical properties of farm-yard manure which he pronounces "the most valuable agent for the improvement of soils." He considers that artificial manures will always be useful auxiliaries, though farm-yard manure must remain the foundation of agriculture.

Comparative Sylvan-Meteorological Observations.—Herr Fankhäuser, Cantonal Forester of Berne.—The observations of the author go to show that the mean temperature of the soil is somewhat lower in a wood than in the open fields. The mean yearly temperature of the air is also higher in the fields than in the woods, the difference being greater in spring and summer than in autumn and winter. In spring and summer the soil is colder than the trees, but warmer in autumn and winter. The air of a forest is more moist than that of the fields, the difference being greatest in summer. Evergreen trees have more action in this respect than such as are deciduous. The mean rain-fall in woods was found greater than in the neighbouring fields, but little value can be attached to this result since it is impossible to estimate the quantity of moisture which runs down the trunks and branches of trees.

Influence of Climate and Weather on the Carbonic Acid of the Ground Air.—Dr. E. Wollny.—The fluctuations of carbonic acid in the ground-air depend on a complication of factors which act sometimes in concert and sometimes in opposition.

Rise of Temperature of Different Constituents of the Soil and Kinds of Soil on the Condensation of Liquid and Aëriform Water and of Gases.—Aug. Stellwagg.—The rise of temperature thus effected deserves consideration only in case of soils rich in humus or in iron, and in a dry condition.

Decomposability of Nitrogenous Animal Matters.—Dr. A. Stutzer and W. Klingenberg.—The authors determined the solubility of dried blood, ground leather, horn-dust, wool waste, &c., by treatment with a solution of pepsine. The results obtained agree substantially with practical conclusions as to the value of the various manurial matters.

Manurial Experiments of the Noorder Afdeeling.—G. Reinders.—A series of experiments have been carried on in Holland since 1870, mainly, it would seem, to test the published views of Prof. G. Ville, and according to the plan proposed in his work. In the first mentioned experiment with oats, Ville's complete manure gave the best results in grain; next came farm-yard manure, chemical manure without nitrogen, ditto without phosphoric acid, (which, however, yielded the heaviest crop of straw). With wheat the following year the results were very different: farm-yard manure took the lead, followed by manure without nitrogen. Then came complete manure, very little better than the unmanured check-plot, and lastly manure without phosphoric acid. For barley, the order obtained was: manure without nitrogen, complete manure, farm-yard manure (very little inferior), the unmanured plot, and manure without phosphoric acid. In straw the complete manure had a distinct advantage. In a more extended set of experiments upon rape-seed, barley, rye, oats, red clover, wheat, and tares, the complete manure proved distinctly superior to farm-yard manure in every case. A manure wanting only in gypsum gave better results for tares and gypsum than the complete manure itself. The absence of phosphoric acid causes the greatest deficiency, then in succession that of nitrogen and of potassa.

Manurial Experiments on Forest Trees.—M. E. Muel.—A complete manuring was not found remunerative, and the addition of nitrogen was prejudicial. Mineral manures assisted the growth of the trees.

Poisoning of Plants.—Dr. C. Krauch.—The author has examined the action of ammonium sulpho-cyanide, of salts of zinc, and of common salt. The first mentioned salt is a violent poison to plants; the second has an injurious action, though it is even necessary for *Thlaspi calaminare* and *Vida multicaulis*. Common salt is not injurious in the proportions in which it is likely to occur in ordinary soils.

Cosmos Les Mondes.
No. 5, February 3, 1883.

Mining by Fermentation.—The yeast of beer has been proposed as a means of breaking up rocks, ores, &c. Experiments are to be performed in the Comstock mines.

MEETINGS FOR THE WEEK.

Monday, March 19.—London Institution, 5.
—— Medical, 8.30.
Tuesday, 20th.—Society of Arts, 8. "Social and Commercial Aspects of New Zealand," by William DeLisle Hay.
—— Institution of Civil Engineers, 8.
—— Pathological, 8.30.
Wednesday, 21st.—Meteorological, 7.
—— Geological, 8.
Thursday, 22nd.—Society of Arts, 8. "Self-Purification of River Waters," by W. N. Hartley, F.R.S.E.
—— London Institution, 7.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Linseed Oil.—Can any of your readers inform me where I can obtain a good process for the refining of raw linseed oil, *i.e.*, deodorising and decolourising?—Sapo.

Blowpipe Analysis.—Benzoline.—Is there any recent work (in English) on the blowpipe which gives a general scheme for the analysis of minerals without the use of liquid tests, something after the style of Dana's tables for identification, only carried out further? Plattner gives a number of reactions, &c., but chiefly with regard to salts and oxides more or less pure. He does not give a method for analysing a *mineral* by blowpipe only without solution and precipitation. What is the best method for purifying commercial benzoline so as to remove the nauseous odour? I suppose that "petroleum ether" is the same thing as benzoline?—Sm.

TO CORRESPONDENTS.

T. R. H.—If the gold is pure it will dissolve in aqua regia without leaving a residue. The deposit you speak of is most probably chloride of silver.

ST. PAUL'S SCHOOL.—An Examination for filling up about Six Vacancies on the Foundation will be held on the 10th April, 1883.—For information apply to the Clerk to the Governors, Mercers' Hall, E.C., or to the School Secretary St. Paul's Churchyard, E C.

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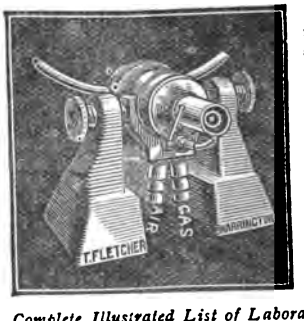

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1217.

NOTE ON THE ORDER OF REVERSIBILITY OF THE LITHIUM LINES.*

By GEORGE D. LIVEING, F.R.S., Professor of Chemistry, and J. DEWAR, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

IN our communications on the reversal of the lines of metallic vapours, we have several times noticed (*Proc. Roy. Soc.*, vol. xxviii., pp. 357, 369, 473), the reversal of the lithium lines, and concluded that the blue line is more easily reversed than the orange line. This, however, does not appear to be really the case. When much lithium is introduced into the arc, a second blue line is developed close to, but slightly more refrangible, than the well-known blue line. This second blue line produces with the other the appearance of a reversal, which deceived us until we became aware of the existence of the second line. The blue line (wave-length 4604) is really reversed without difficulty when sufficient lithium is present, but under these circumstances the orange line is also reversed. The latter line is also the one which first (of the two) shows reversal, and also the one which is more persistently reversed. Hence we place the lines in order of reversibility as follows: red, orange, blue, green, violet.

ON SOME COLOURING MATTERS BELONGING TO THE ROSANILINE SERIES.

By RAPHAEL MELDOLA.

NAPHTHYLATED derivatives of rosaniline analogous to the phenylated blues are at present imperfectly known owing to the difficulty of substituting the radicle $C_{10}H_7$ for the amido-hydrogen of rosaniline by the ordinary method. I found some time ago, however, that this substitution could be readily effected by employing β-naphthylamine. It is only necessary to heat the rosaniline base with an excess of the β-naphthylamine to a temperature a few degrees above the melting-point of the latter for a short time (about 15 to 20 minutes), in the presence of a small quantity of benzoic or acetic acid, when ammonia is freely evolved, and a rich blue melt is produced. The product, after purification by the usual methods, can be converted into sulphonic acids, which dye silk or wool of a deep blue, having a more reddish tint than the corresponding sulpho-acids of triphenylrosaniline. Pararosaniline was employed in this experiment so that the constitution of the tri-β-naphthyl-pararosaniline base might be thus represented:—

$$(HO)C\begin{cases} C_6H_4.NH.\beta C_{10}H_7 \\ C_6H_4.NH.\beta C_{10}H_7 \\ C_6H_4.NH.\beta C_{10}H_7 \end{cases}$$

An experiment was also made, having for its object the production of a phenylated derivative of pararosaniline by direct oxidation. Thus, when a mixture of one molecule of paratoluidine and two molecules of diphenylamine is heated in the presence of an oxidising agent, the following reaction might be expected to take place† :—

$$NH_2.C_6H_4.CH \begin{cases} \cdots H \\ H_2 + \\ \cdots H \end{cases} \begin{matrix} C_6H_4.NH.C_6H_5 \\ \\ C_6H_4.NH.C_6H_5 \end{matrix} + 3O =$$

$$NH_2.C_6H_4.C\begin{cases} HO \\ C_6H_4.NH.C_6H_5 \\ C_6H_4.NH.C_6H_5 \end{cases} + 2H_2O.$$

The experiment was found to be successful when the mixed ingredients were dissolved in glacial acetic acid and heated for some time (two to three hours) with the theoretical quantity of As_2O_5 necessary to furnish the requisite amount of oxygen. The product, when purified, was a purple dye-stuff, which could be converted into a sulphonic acid by the ordinary methods, and possessing all the properties of a diphenyl-rosaniline.

Atlas Works, London, E.

ANALYSIS OF ASH OF *PISTIA STRATIOTES*, "PÁNÁ SALT."

By C. J. H. WARDEN, Bengal Medical Staff, Chemical Examiner to Government.

THE *Pistia stratiotes* plant is described by Roxburgh as found swimming on pools of stagnant water in most parts of India, and having much the appearance of half-grown lettuce plants. In Bengalee and Hindoostanee it is known as "taka pánná," and the saline matter obtained by lixiviation of its ash as "páná salt."

In the Dinagepur district this salt is prepared as follows: A large quantity of the plant is collected in the cold season, when it becomes matured, and dried and incinerated. The ash is then put into a piece of cloth, tied between pegs, and percolated with water, and the saline solution evaporated to dryness in a pot over a fire. According to the Collector of Dinagepur, páná salt is not largely manufactured in that district; the little that is made is almost entirely used for medicinal purposes by Kubirajis and as a domestic remedy. It is very rarely employed as a substitute for common salt.

Specimens of the plant, and salt, were received from the Kinagepur district, and yielded on analysis the following results. The weed, dried at 130° C., was carbonised at a temperature below redness and exhausted with boiling distilled water: the insoluble residue being subsequently incinerated until free from carbon.

Total ash	31·4583	per cent.
Soluble ash	6·1426	,,
Insoluble ash	25·3463	,,

The sample of páná salt weighed about 2 lbs., it was slightly deliquescent, alkaline in reaction, and had the appearance of dirty common salt. Dried at 130° C. it had the following percentage composition:—

Potassic chloride, KCl	73·0916	per cent.
Potassic sulphate, K_2SO_4 ..	22·6130	,,
Potassic carbonate, K_2CO_3 ..	traces	
Sodic chloride, NaCl	0·4727	,,
Calcic sulphate, $CaSO_4$ ..	0·5874	,,
Magnesic sulphate, $MgSO_4$ ..	0·2574	,,
Ferric and aluminic oxides, Fe_2O_3, Al_2O_3	0·0982	,,
Sand and silicic oxide, SiO_2	0·3673	,,
Organic matter	0·3575	,,
Water	1·8674	,,
	99·7125	,,

Nitrates, nitrites, and phosphates were absent. Not

* A Paper read before the Royal Society, March 8, 1883.

† The free base of the substituted rosaniline is assumed to be produced for the sake of simplicity.

the slightest trace of either bromine or iodine could be detected.

This analysis is of interest as showing the large amount of saline matter which may exist in a water-weed. Parkes remarks in his "Manual of Hygiene" (p. 30), "It should also be remembered that some water plants have a purifying effect, apparently from the large amount of oxygen they give out: and this takes place sometimes though the water itself is green." It appears probable that aquatic plants possess not only the power of indirectly oxidising dissolved organic matter, but also of removing saline substances from water. When sewerage is placed on the ground, vegetation is encouraged in order to render animal matter innocuous, and there does not appear to be any valid reason why a similar procedure should not be applicable and equally beneficial in the case of contaminated water. The desirableness, therefore, of allowing water-weeds to grow freely in Indian tanks—which are always extremely liable to pollution—need hardly be urged.

But in order to derive benefit from aquatic plants, tanks should be cleaned periodically. The danger of permitting weeds to remain in water during the hot weather is alluded to by Drury ("Useful Plants of India"). He states that "in Jamaica the *Pistia stratiotes*, in the hot dry weather, impregnates the water with its particles to such a degree as to give rise to the bloody-flux." In the hot weather, when the volume of water in a tank is reduced through evaporation, &c., any contaminating material gaining access would be introduced into the system in a less diluted form than when the same tank was full. The object should therefore be to facilitate oxidation as much as possible.

The higher the temperature of the water the more rapid is oxidation likely to be, and a water in the hot weather freely exposed to the action of heat, light, and air, is less likely to retain deleterious organic matter in an active form than the same water covered with a layer of floating vegetation. In the cold weather, on the other hand, when tanks are full, the indirect oxidising power possessed by aquatic plants might be utilised to assist in the destruction of organic matter, and in the removal of inorganic salts which may have been washed into the water by rainfall.

Bearing in mind the exposed condition of most Indian tanks, and the numberless sources of pollution to which they are exposed, it seems probable that it is only on such grounds that the absence of ill effects ensuing in then using the water can be explained. The mouths of wells, in most instances, are slightly raised above the level of the ground, so that, as a rule, contaminating matter has to filter through a certain depth of soil before reaching the water, and is there rendered innocuous, but when sewerage does gain direct entrance it appears to retain its toxic powers for a prolonged period, this being doubtless due to the low temperature of the water, and the more or less absence of light, aquatic plants, and stagnation of the air.

Medical College, January 24, 1883.

Royal Institution.—The following are the the arrangements for the Lectures after Easter:—Professor J. G. M'Kendrick, ten lectures on "Physiological Discovery;" Dr. Waldstein, four lectures on the "Art of Pheidias;" Professor Tyndall, three lectures on "Count Rumford, Originator of the Royal Institution;" Mr. R. S. Poole, three lectures on "Recent Discoveries in (1) Egypt, (2) Chaldæa and Assyria, (3) Cyprus and Asia Minor;" Mr. A. Geikie, six lectures on "Geographical Evolution;" and Professor C. E. Turner, four lectures on "Historical Sketches of Russian Social Life." The discourses on the Friday evenings will probably be given by Mr. A. Geikie, Dr. Waldstein, Professor B. Balfour, Mr. C. W. Siemens, Mr. R. A. Scott, and Professors Huxley, Turner, Flower, Pollock, and Dewar.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING FEBRUARY 28TH, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

March 5th, 1883.

SIR,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the month of February, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 168 samples, two were recorded as slightly turbid, and five as very slightly turbid. The remainder were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 28th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 24 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Chelsea Water Company, one was recorded as "very slightly turbid." The remainder were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Lambeth Water Company, two were recorded as "very slightly turbid," the remaining 22 samples being well filtered, clear, and bright.

Of the 24 samples from the mains of the Grand Junction Company, six samples were recorded as "very slightly turbid," the remaining 18 samples being found well filtered, clear, and bright.

Of the 24 samples from the mains of the Southwark and Vauxhall Company, two were recorded as "very slightly turbid," the remaining 22 samples being found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

The proportion of organic matter found in the water has continued to be much the same as that observed during the previous month; although the maximum amount found in one particular sample taken in January has not since been met with. The condition of the water in respect to its freedom from turbidity has been noted in the preceding paragraphs.

We have the honour to remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE

USE OF LITMUS, METHYL-ORANGE, PHENACETOLIN, AND PHENOL-PHTHALEIN AS INDICATORS.*

By ROBERT T. THOMSON.

(Concluded from p. 127).

XI. *Effect of Silicate of Sodium.*

A PRELIMINARY test was made of the value of litmus for the estimation of soda in silicate of sodium by taking a quantity of hydrate of sodium of known strength, dissolving some silicate in it, and then determining the soda. The exact amount of soda used was found, and the estimation made by litmus was taken as the standard of comparison with the results obtained with the other indicators. 5 grms. of commercial liquid silicate of soda were employed, and 15·05 c.c. of normal acid were consumed with litmus as indicator, the end-reaction taking place with great distinctness.

With *Methyl Orange*, also, a very distinct end-reaction was obtained, and 15·1 c.c. were consumed, a result closely corresponding with the former one.

Phenacetolin gives a dark pink colour with the silicate of sodium, but this became yellowish towards the end of the test, and the change was not very distinct. 15 c.c. of the acid were necessary, which does not materially differ from the quantities obtained with litmus and methyl-orange.

Phenol-phthalein.—The red colour produced by the phenol-phthalein was slowly destroyed on running the acid into the cold silicate solution, 12·7 c.c. only being required. When boiled, the colour returned, but was dispelled when 13·5 c.c. had been added. These results are considerably below the truth.

TABLE VIII.

Results obtained in the titration of silicate of sodium ($Na_2Si_4O_9$).

Name of Indicator.	C.c. Normal Acid consumed.	Grm. of Na_2O found.
Litmus	15·05	0·466
Methyl-orange	15·1	0·468
Phenacetolin	15·0	0·464
Phenol-phthalein (cold) ..	12·7	0·393
,, (boiled)..	13·5	0·418

XII. *Effect of Alumina.*

Soluble alumina, like silica, is seldom or never absent from caustic soda or potash. The experiments were made with an excessive quantity of alumina, the proportion used being equal to about 8 per cent in an average strength caustic soda. A quantity of pure hydrate of aluminum, equal to 0·515 grm. Al_2O_3, was prepared from alum by precipitation with ammonia. This precipitate was redissolved, re-precipitated, washed thoroughly, dissolved in 125 c.c. of normal caustic soda, and made up to 250 c.c. with water. 50 c.c. of this was employed for each test, and contained 0·775 grm. of soda, and 0·103 grm. of alumina.

Litmus.—When litmus was used 25·25 c.c. of the normal acid were consumed in place of 25 required when no alumina was present, nor did the end-reaction come out very distinctly.

Methyl-orange.—After a little more than 25 c.c. of the acid had been consumed, the alumina was all precipitated, and then gradually dissolved, the pink colour at first produced being quickly dispelled as the acid combined with the alumina. A decided and permanent change occurred when 30·7 c.c. had been added. This gives 0·951 grm. of soda as against 0·775 really present, and if the difference be calculated to alumina, it shows 0·097 grm. of the latter compound instead of 0·103. It is thus evident that nearly the whole of the alumina has been estimated along with the soda.

With *Phenacetolin* and *Phenol-phthalein* the real amount of soda used was obtained. The only effect of the precipitated alumina is to obscure the end-reaction slightly.

TABLE IX.

Results obtained in the titration of aluminate of soda.

Na_2O used for each test	0·775 grm.
Al_2O_3 ,, ,, ,, ...	0·103 ,,
$= Na_2O$,, ,, ,, ...	0·186 ,,

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of Na_2O found.
Litmus	25·25	0·782
Methyl-orange ..	30·7	0·951
Phenacetolin	25·05	0·776
Phenol-phthalein ..	25·0	0·775

XIII. *Effect of Nitrite of Sodium and Potassium.*

A solution of nitrite of potassium was prepared by decomposing with chloride of potassium a known weight of nitrite of silver, which was precipitated from a solution of nitrite of sodium. 20 c.c. of this nitrite of potassium liquor contained 1·7 grm. of KNO_2, and this quantity diluted to 100 c.c. was employed for each test. The nitrite was found to be quite neutral to litmus, phenacetolin, and phenol-phthalein. With methyl-orange, however, the pink colour was not produced, even after adding 30 c.c. of normal acid, but seemed to be destroyed at once by the liberated nitrous acid. Another quantity containing 0·085 grm. of the nitrite in the 100 c.c. gave a pink colour with 0·2 c.c. of acid, but this was slowly dispelled on standing a few minutes, leaving a pale yellow colour. Nitrite of sodium acts in the same way towards the indicators as nitrite of potassium. Nitrites are sometimes found in small proportion in caustic soda and potash.

XIV. *Determination of Soda in Borax.*

The solution of borax employed contained 1·683 grms. of pyroborate of sodium in 50 c.c., the quantity used for each test.

With *Litmus* the blue colour began to purple when 13 c.c. had been added, but the change was not complete until 16·65 in the one case and 16·6 c.c. of normal acid in the other had been consumed. This shows 0·516 and 0·514 grm. of soda, as against 0·516 really present. The end-reaction, however, is very indistinct.

Methyl-orange is by far the best indicator for the estimation of soda in borax, and is, indeed, perfect in that respect. The change in colour at the end of the experiment was very sharply defined. The results agreed closely with those of litmus.

Phenacetolin.—Like litmus the colour of this indicator slowly changes, and a good end-reaction is therefore impossible. The whole of the soda can be estimated by it.

Phenol-phthalein is utterly useless for the purpose under consideration. The red colour disappears before half of the soda is determined in cold solutions. When boiled a much higher result is obtained, but still very far below the truth.

TABLE X.

Determination of Soda in Borax.

$Na_2B_4O_7$ used for each test	1·683
$= Na_2O$,, ,, ,, ...	0·516

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of Na_2O found.
Litmus	16·65—16·6	0·516—0·514
Methyl-orange..	16·7 —16·65	0·518—0·516
Phenacetolin	16·7 —16·6	0·518—0·514
Phenol-phthalein (cold)..	7·6 — 7·8	0·235—0·242
,, (boiled)..	11·0 —11·3	0·341—0·350

* A Paper read before the Philosophical Society of Glasgow (Chemical Section), January 22, 1883.

XV. *Determination of Free Sulphuric, Nitric, and Hydrochloric Acids.*

It is quite plain, from the results obtained when testing the behaviour of the sulphates, chlorides, and nitrates of the alkalies with the indicators under consideration, that these acids can be determined by a standard caustic alkali, excepting that ammonia cannot be used with phenol-phthalein. Carbonate of sodium can be used in the cold if methyl-orange is employed, and in the case of phenacetolin the caustic potash or soda should contain a little carbonate of potassium or sodium, so that the carbonate or bicarbonate will be formed when the end-reaction is reached, and the dark pink colour will be produced.

XVI. *Determination of Free Oxalic Acid.*

A normal solution of pure oxalic acid was prepared, and 20 c.c. of this was employed for each test.

With *Litmus* the end-reaction was very well defined, and exactly 20 c.c. of normal hydrate of sodium were consumed, thus giving exactly the amount of oxalic acid.

Methyl-orange.—It has been pointed out by Lunge that methyl-orange must not be employed when oxalic acid is titrated, and from the following test it is evident that it cannot be relied on. When 12 c.c. of the normal alkali were added the pink colour began to fade away, and was completely destroyed after the addition of 18 c.c.

Phenacetolin.—The addition of 19·8 c.c. produced a very faint pink colour, which was not fully developed till 20 c.c. had been consumed. This indicator cannot, therefore, be recommended as useful for the titration of oxalic acid.

Phenol-phthalein, on the contrary, works admirably, the end-reaction being as delicate as with the mineral acids. The result agreed with that of litmus.

TABLE XI.

Determination of Oxalic Acid.

$H_2C_2O_4$ used for each test .. .. 0·900 grm.

Name of Indicator.	C.c. of Normal NaHO consumed.	Grm. $H_2C_2O_4$ found.
Litmus	20·0	0·900
Methyl-orange	18·0	0·810
Phenacetolin	19·8	0·891
Phenol-phthalein ..	20·0	0·900

XVII. *Determination of Acetic Acid.*

The sample of acetic acid in which the free acid was determined showed a specific gravity of 1·0472 at 15° C., which is equal to, according to Oudeman's table, 35·02 per cent of $HC_2H_3O_2$. 100 grms. of this acid were made up to 1 litre with water, and 50 c.c. used for each titration, the caustic alkali used being standardised with normal sulphuric acid.

Litmus.—On adding the normal caustic soda the red colour remained intact, but towards the end of the experiment became purple, and almost blue before the end-reaction was accomplished. The last change in colour could only be observed by comparison with a blue litmus solution of the same strength as the liquid operated upon. 29·15 c.c. were consumed both with this experiment and with one tested with litmus paper, 1·749 grm. of acetic acid being obtained in each case.

Methyl-Orange is totally useless as an indicator in the estimation of acetic acid, only 3·5 c.c. of the alkali being consumed.

Phenacetolin.—The addition of 28 c.c. produced a pale rose-colour, but the change was very undecided. This indicator is not adapted for this purpose.

Phenol-phthalein is well fitted for use in the estimation of free acetic acid by caustic soda, as acetate of sodium is perfectly neutral to it, while that salt is alkaline to litmus. Several tests gave 29·2 c.c. of normal alkali consumed, these results being slightly, but quite distinctly, higher than those obtained with litmus. The end-reaction is as delicate and sharply defined as in the determination of the mineral acids. If the solution in which the acetic acid is to be determined is dark-coloured (as in some vinegars) it may be highly diluted, as dilution has little or no effect on the delicacy of phenol-phthalein.

TABLE XII.

Determination of Acetic Acid.

Name of Indicator.	C.c. of Normal NaHO consumed.	Grms. of $HC_2H_3O_2$ found.
Litmus..	29·15—29·15	1·749—1·749
Methyl-orange ..	3·5	2·10
Phenacetolin ...	27·8	1·668
Phenol-phthalein .	29·2 —29·2	1·752—1·752

XVIII. *Determination of Tartaric Acid.*

1·5 grms. of pure and dry tartaric acid were used for each experiment. The solution tested with litmus as indicator began to get purple after the addition of 19 c.c. of normal caustic soda, but the change to blue was not complete till 20 c.c. had been consumed, the tartaric acid found being exactly equivalent to the quantity taken. As with oxalic and acetic acids, *Methyl-orange* gives very low results, 16 c.c. only being required to dispel the pink colour. The tartaric acid found by *Phenacetolin* was slightly but perceptibly under the truth. *Phenol-phthalein* in this case, as with acetic acid, is the only perfect indicator among these four. Although the results obtained are much the same as those with *Litmus*, the unimpaired delicacy of the end-reactions gives *Phenol-phthalein* a great advantage over the former indicator.

TABLE XIII.

Determination of Tartaric Acid, $H_2C_4H_4O_6$, used for each test 1·5 grms.

Name of Indicator.	C.c. of Normal NaHO consumed.	Grms. of $H_2C_4H_4O_6$ found.
Litmus..	20·00—20·00	1·500—1·500
Methyl-orange ..	16·00	1·200
Phenacetolin ..	19·85	1·488
Phenol-phthalein .	20·00—20·00	1·500—1·500

XIX. *Determination of Citric Acid.*

The sample used for the following tests was found to be free from impurity, but, as the water of crystallisation varies to some extent, it was determined by drying for about twelve hours between 50° and 60° C., and then gradually raising the temperature to 100°. 8·53 per cent was obtained, which is slightly lower than the theoretical proportion of 8·57 per cent. As 14 grms. were made up to 200 c.c., 20 c.c. contained 1·2806 grms. of dry citric acid ($H_3C_6H_5O_7$), this being the quantity operated upon. The normal caustic soda was standardised by normal sulphuric acid.

Litmus seems still to be considered the best indicator for the estimation of free citric acid, but it is a very defective one. In the first place it gives a very indefinite end-reaction, and in the second the normal citrate of soda formed during titration is so alkaline as to preclude the use of sulphuric or any other mineral acid in the standardising of the caustic soda. Pure citric acid must in that case be employed as the standard, and this entails the testing for impurities and the tedious estimation of water described above. Allen, in his "Commercial Organic Analysis" (vol. i., p. 263), noticing these points, observes that neither logwood nor cochineal gives sharp end-reactions, and recommends the use of carefully-prepared litmus paper. In the two tests I made both litmus solution and paper were used, the last change in colour of the former being observed by placing it side by side with a litmus solution of equal strength, to which a little alkali had been added. The results were identical, 19·7 c.c. of the normal alkali being consumed in each case. This shows 0·02 grm. too little of citric acid, and is to be attributed to the alkalinity of the citrate, as sulphuric acid was made use of in testing the standard caustic soda.

Methyl-orange and *Phenacetolin* were found to be of no value in the titration of citric acid, 9 c.c. being consumed with the former and 17 with the latter.

Phenol-phthalein.—This indicator is again distinguished from the others by its great delicacy in the determination of free citric acid, as it is in that of tartaric and acetic acids. Several tests were made, and in every case 20 c.c. of the normal acid were consumed, giving results extremely close to the real amount of citric acid present. Phenol-phthalein has thus two advantages over litmus for the determination of citric, tartaric, and acetic acids:—1st, it gives a sharply defined end-reaction; and 2nd, sulphuric acid can be employed in standardising the caustic soda.

TABLE XIV.

Determination of Citric Acid, Sulphuric Acid being used for the Standardising of the normal Caustic Soda.

$H_3C_6H_5O_7$ used for each test .. .. 1·2806 grms.

Name of Indicator.	C.c. of Normal NaHO consumed.	Grm. of $H_3C_6H_5O_7$ found.
Litmus..	19·7—19·7	1·2608—1·2608
Methyl-orange ..	9·0	0·5760
Phenacetolin ..	17·2	1·1000
Phenol-phthalein .	20·0—20·0	1·2800—1·2800

Litmus and phenol-phthalein were further tested with a sample of lime-juice, in order to make certain that a similar difference in result would be brought out when these indicators were applied to the determination of citric acid in this substance. Of course the other free acids existing in the juice would be included in the result. 10 c.c. of the sample measured at 15·5° C. were employed.

Litmus Paper was used as indicator, as the yellow colouring-matter of the lime-juice darkens so much as to make litmus solution useless. 13·0 and 13·05 c.c. of normal alkali were consumed, which give 36·5 grains of dry citric acid per ounce, 30 grains per ounce being the Board of Trade standard.

Phenol-phthalein.—With this indicator the most convenient quantity to use is 10 c.c. of the juice diluted to 150 or 200 c.c. As the yellow colouring-matter becomes darker towards the end of the experiment, the end-reaction is not quite so delicate as in a colourless solution, but can still be recognised without the least difficulty. 13·25 c.c. of the normal alkali were consumed in each case, these results being equal to 37·1 grains of dry citric acid per ounce.

TABLE XV.

Determination of Free Acids in Lime-Juice.

10 c.c. of sample used for each test.

Name of Indicator.	C.c. of Normal NaHO consumed.	Grains of $H_3C_6H_5O_7$ per ounce.
Litmus..	13·00—13·05	36·40—36·54
Phenol-phthalein .	13·25—13·25	37·10—37·10

Continued p. 184

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 15, 1883.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—T. L. Briggs, E. C. Conrad, C. Gillett, L. Levy, A. Ness, V. I. Schopoff, A. E. Wilson.

Dr. GILBERT announced that the Anniversary Meeting would take place on Friday, March 30, and that he had decided, after much deliberation, to resign the office of President. The Council proposed that Dr. W. H. Perkin should fill the vacancy thus created, and that Mr. J. Millar Thomson should be Secretary.

Mr. T. MATTHEWS then read a paper "*On Some Condensation-Products of Aldehyds with Aceto-acetic Ether and with Substituted Aceto-acetic Ethers.*" The author has studied the following reactions:—Condensations of acetic ether with isobutylic aldehyd, with valeric aldehyd, with chloral, with furfurol, and with acrolein; of benzoic aldehyd with aceto-diethyl-acetic ether, with aceto-dichlor-acetic ether, with aceto-benzyliden-acetic ether, and with aceto-monoethyl-acetic ether. He concludes that aceto-acetic ether is capable of condensing with aldehyds of all descriptions, and that the condensation takes place only in the methylen group, but with the greatest ease; that mono- and di-substituted aceto-acetic ethers, with the exception of the dichlor ether, are capable of condensing with benzoic aldehyd, but the condensation is much more difficult to effect, and it takes place only in the methyl group.

Mr. R. WARINGTON communicated a paper entitled "*Contribution to the Chemistry of 'Fairy Rings,'*" by Sir J. B. LAWES, J. H. GILBERT, and R. WARINGTON. The circles of dark green grass which frequently occur on pasture-land, and which have been long known by the name of "Fairy Rings," have attracted much attention from botanists and vegetable physiologists. Prof. Way in 1846 explained this phenomenon as follows:—"A fungus is developed on a single spot of ground, sheds its seed, and dies. On the spot where it grew it leaves a valuable manuring of phosphoric acid and alkalies, &c.: the ground then becomes occupied by a vigorous crop of grass, rising like a phœnix on the ashes of its predecessor. The grass crop is then removed, and with it the greater part of the inorganic materials the fungus had collected." Prof. Way therefore attributed the effect chiefly to the inorganic elements. Many experiments were made on the subject at Rothamsted, and in 1851 (*Jour. Roy. Agr. Soc.*, vol. xii., p. 32) it was stated that the manuring action was due to the nitrogen collected by the fungus rather than to the ash constituents. The source of the nitrogen was at that time supposed to be the atmosphere. Since that time, however, much evidence has been acquired as to the sources of the nitrogen of green-leaved plants, and grave doubts have arisen as to the nitrogen being derived from the atmosphere. In 1874 an attempt was made to obtain direct experimental data on the subject. Samples of soil were taken of the soil, inside a fairy ring, from the ring, and outside. The organic carbon and nitrogen were carefully estimated. The mean results obtained were:—Nitrogen within the ring, 0·247 per cent; on the ring, 0·266 per cent; outside, 0·281 per cent. Carbon within, 2·78 per cent; on the ring, 2·99 per cent; outside, 3·30 per cent. The percentage of nitrogen and carbon is therefore highest in the soil outside the ring, and lowest within the ring, whilst the quantities found in the soil from the ring have an intermediate value: it is obvious, therefore, that the growth of the fungus, and the subsequent increased growth and removal of the associated herbage, is accompanied by a considerable reduction in the amount of the organic carbon and nitrogen in the soil, or that fungi have taken up organic carbon and nitrogen from the soil which was not available to the previously established vegetation. Five series of experiments were made, and the investigation would have been continued, but, owing probably to the late wet seasons, the fairy rings have disappeared from Rothamsted. The soil of the ring always contained more nitrates than the soil either within or without.

Dr. GILBERT said that the point of interest in the paper was the source of the nitrogen. These rings usually occurred on very poor pastures, and it was at first natural to suppose that the fungi must draw the nitrogen from another source, as the previous vegetation could not obtain it from the soil; and although we have no evidence that green-leaved plants can obtain nitrogen from the atmosphere, it was thought that with fungi, whose growth is so

different, it might be otherwise. Direct evidence that the nitrogen comes from the soil is still wanting, but there is a great deal less evidence that the nitrogen is furnished by the atmosphere, so that on the whole the balance of evidence points to the soil as the source of the nitrogen.

The SECRETARY then read a paper "*On Lines of no Chemical Change*," by E. J. MILLS and W. McD. MACKAY. The authors considered it of great interest to to determine in certain cases the origin of chemical change, such origin being obviously identifiable in many instances with a line of no chemical change. In the present paper they have studied the reaction between sulphuric acid and zinc brought in contact under definite conditions as regards temperature, strength of acid, &c. The hydrogen evolved was taken as the index of the extent of the reaction. The results are contained in tables, and are plotted on a curve. The nature of the reaction is shown to be of a very complicated character. The law of the relation of temperature to chemical change requires an equation of the second degree. The authors state that their investigations place temperature on the footing of an ordinary chemical reagent. They intend to resume this investigation.

The SECRETARY then read a paper "*On Homologous Spectra*," by W. N. HARTLEY. In June 1881, the author published (*Journ. Chem. Soc.*, 134, 84) a note on certain photographs of the ultra-violet spectra of elementary bodies, and attention was directed to the extraordinary similarity between the groupings of lines in the spectra of magnesium, zinc, and cadium, copper and silver, iron, cobalt, and nickel. It was thus made evident that the spectra of elements of the same homologous series present either homologous spectra or homologous groups of lines in their spectra; but it was remarked, "it will be hopeless to determine whether there are numerical relations between the wave-lengths of different groups of lines until the spectra have been reproduced on an enlarged scale, and the wave-lengths for the principal lines of the different elements calculated." Ciamician has remarked that almost every element has a number of feeble lines which bear the same relation to the chief line or lines that the overtones in music bear to the fundamental note. These observations, however, refer only to the visible rays, or about one octave of the spectrum; photographs of the ultra-violet region can easily be extended to more than two octaves. The conclusions of Ciamician are completely confirmed by such extended photographs. The three hydrogen lines, *h*, F, and C, have been shown to be the 32nd, 27th, and 20th harmonics of a fundamental vibration whose wave-length is 0·01313 m.m. There is evidently a harmonic relation between the lines in the spectra of magnesium, zinc, cadmium, aluminium, and in those of calcium, strontium, and barium, when two octaves of the spectra are examined. The fundamental vibrations appear to be all in the infra-red region. The author originally intended to bring forward an extended series of observations on the constitution of the spectra of the elements, but as it appears that Liveing and Dewar are engaged in a similar research, the author wishes to publish such facts as he has already obtained. In order that harmonic relations between lines and groups of lines may be rendered apparent it is necessary to map spectra according to their "oscillation-frequencies" instead of wave-lengths. The author has thus mapped the wave-frequencies in one millimetre of the chief rays in the spectra of magnesium, zinc, cadmium, copper, silver, silicon, boron, and aluminium. The data thus obtained present a considerable addition to the body of evidence in support of the view that elements, whose atomic weights differ by a constant quantity and whose chemical character is similar, are truly homologues, or in other words are the same kind of matter in different states of condensation. The probability of the fundamental vibrations of the simpler elements being found in the infra-red region will doubtless be soon tested, since Capt. Abney has enabled us to photograph this region, and with the help of Rowland's exquisite concave ruled specula, we have now a range of four octaves of the spectrum.

The Society then adjourned to April 5, when a paper "On the Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal gas," by L. T. Wright, will be read.

The Anniversary Meeting is on Friday, March 30.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, February 20, 1883.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

A COMMUNICATION from Dr. JOULE, F.R.S., was read, on the use of lime as a purifier of the products of combustion of coal-gas.

The slaked lime is placed in a vessel, the bottom of which, about one foot diameter, is slightly domed and perforated with fine holes. The vessel is suspended about 6 inches above the burner. It is found that a stratum of 4 or 5 inches of lime is sufficient to remove the acid vapours so far as to prevent them from reddening litmus-paper. The lime seems in many respects to present important advantages over the zinc previously recommended.

Mr. R. D. DARBISHIRE, F.G.S., read a "*Note upon the Mammoth Cave*," by Mr. G. DARBISHIRE.

Afrer leaving the old "blue grass" formation* to the east and crossing the Louisville rocks, one approaches the dry lands of the "sub-carboniferous formations."†

Here the rainfall is carried off by "sink-holes," and, except where important streams flow in open gorges 300 to 350 feet below the plain, the drainage is all underground. Sink-holes are sometimes isolated funnels in the middle of depressions which might still hold lakes unless so drained, and probably did so once, and sometimes are the outlets at the bottom of dry ravines which have no mouths. The water entering these sink-holes passes away through cracks and caverns hollowed out of the weaker places in the rocks. When such a cavern channel is formed near the surface the roof falls in at places, and a more or less open ravine appears. At times the sink-holes, after using an upper series of caverns for ages, have drilled downwards by means of the gravel and rock churning in the bottoms of pot-holes till the water has found lower outlets, and when it has eaten out on lower levels waterways sufficient for the rainfall of the district, the upper caverns are deserted, the muds washed in harden on the floor, and pieces of the roof becoming detached, partially fill the unused ways with *débris*. As

* "The cultivated district of central Kentucky, commonly known as Blue-grass District, is perhaps for its area the most beautiful rural district in America. The surface is undulating, large areas of the original forests have been cleared of their undergrowth, and produce a fine close sod, and in these wood-pastures are some of the finest flocks and herds in the world. It has happened to the writer to pass on several occasions from this region to the richest lands of middle England, or *vice versa*, and he has always been struck by the singular likeness of the two countries. There is probably a closer resemblance between the surface of the country, the cattle, horses, the agriculture, and even the people of these two areas than any two equally remote regions of the world"—From General Account of the Commonwealth of Kentucky ("Geological Survey"), vol. ii., p. xi.

† All this region wants the small valleys which we are accustomed to see in any country; but in their place the surface is covered by broad, shallow, cup-like depressions or sink-holes, in the centre of which is a tube leading down to the caverns below. All this region is completely honeycombed by caverns, one level below the other, from the surface to the plane of the stream below. In one sense this set of underground passages may be regarded as a continuous cavern as extensive as the ordinary branches of a stream when it flows upon the surface. The sink-holes answer to the smallest extremities of the branches. Some idea of the magnitude of these underground ways may be formed by the fact that the Mammoth Cave affords over 200 miles of chambers large enough for the passage of man, while the country in which it occurs has over 500 openings leading far into the earth, none being counted where it is not possible to penetrate beyond the light of day.

this goes on, stalactitic and florescent stalagmitic formations accumulate in these stormless old river channels. The sign of water action in the rocks is wonderfully preserved, and tells its tale of stream-wear or drift-wear more faithfully than in valleys exposed to rains, vegetation, and changes of temperature. The unaccustomed darkness and the strange shadows cast by the lamps of visitors give to these accumulations, masses of *débris*, and water-worn roofs and walls, weird shapes which are fancifully supposed to resemble familiar objects above ground. Their own individualities, so different from anything on the surface, give them a far stronger claim on the observer's interest.

Amid slightly undulating woodlands, about 325 feet above Green River, lies a depression some 80 feet deep, and at one place the sandstone bottom of this depression has fallen away, exposing an opening into the "Mammoth Cave," whose upper and lower chambers are known to extend for 200 miles, and to communicate with further unexplored channels.

After a descent from the open air of about 60 feet the floor of the "Water Cave" is reached. This has been dry as long as it has been known. Indeed, as it is nearly 200 feet above Green River (the drainage level in this district), the water must for ages have been able to traverse large lower channels.

The old deposits of mud in these upper caves have been so saturated with saltpetre that they have been washed as early as the war of 1812. On the theory that this saltpetre is derived from bat-guano, acted on by the dry atmosphere of the cave, a long period of inaction as a river channel must be allowed for. The number of bats is certainly great, but their lease of the premises during which nitre has been thus accumulated must have been a long one.

For convenience of tourists and guides the caverns are usually visited by what are called the *short* or the *long* routes, about 3½ and 8 miles long respectively. The short route leads for a considerable distance through the main cave amid the workings of the saltpetre diggings. This main cave, nearly 4 miles in length, has an average width of 60 feet and a height of 40 feet above the present floor, which is formed of *débris* and alluvial deposits considerably deep over the real rock floor. Owing to peculiar causes in this dry cave the earth has hardened, and in places the guide points out footprints of the oxen used by the miners not earlier than the beginning of the century, in clay now nearly as hard as rock. The corn-cobs used long ago are still undecayed.

The short route leads visitors from the main cave down by a broken opening to a lower range of caverns in the limestone. These, after passing through various chambers and galleries, lead to a series of "domes and potholes." The "domes," or portions of the pot-holes extending upwards, are no doubt connected with the funnels of some slough-like depressions in the ground above, and have supplied water to the various levels of caverns in their turn, while the holes, having bored some 65 feet lower down, open into the present drainage avenues below. The vertical height of these shafts as visible at present is from 200 to 230 feet, and their diameter about 25 feet, a size due to the cutting power of the gravels in the pothole, and far in excess of anything required by the volume of water to be removed.

On the long route, after leaving the main cave and descending to the "deserted chambers," a second descent leads to the third series of caves, also dry in the present age. Presently the track sounds hollow, and at places, openings in the floor reveal a fourth series of chambers. Descending to these, one reaches the level of medium high-water mark. A descent of 30 feet brought us to the water, which, on 1st of November, after the protracted drought, was about 300 feet below the Hotel by my aneroid, or 24 feet above Green River. Here then is reached a cave that is still in use, and the roof shows that these caverns are often quite filled with water.

After crossing several pools, the Echo River is reached, showing a slight current on its surface. The depth of this stream varies from 5 to 10 feet, and its width is from 20 to 200 feet, but probably the deeper parts are nearly still pools. Rowing along this for three quarters of a mile, avenues are next traversed which for a long distance show the mechanical and chemical erosions of the water-flow, and chambers are reached where the roofs and sides are covered with florescent formations of gypsum, the long fibrous bunches of crystal curving outwards from some centre, forming delicate rosettes from one to six inches in diameter, and as beautiful as flower-like sea anemones; but, unfettered by the bonds of species, every variety of form appears, white, yellow, or black, and all adorned with glittering crystals.

At last, after a scramble over *débris* (called "the Rocky Mountains,") which has piled up to a height of 200 feet above the water, or a little above the top of the entrance of the main cave, the roof is seen to change. It is above the limestone, and the naked sandstone stretches from side to side. A little further on "the Maelström" is reached, another huge pothole, in which the gravels at the bottom are but little above the present water-level, while the dome reaches far up into the sandstone.

On the return journey, a short cut is made up what is called "the Corkscrew." In reality it is a scramble up a cleft in the rocks nearly choked by *débris*, the top of which is also very near the sandstone. To give an idea of the vastness of this underground drainage I copy from the Guide Book a few dimensions relating to this one cave, and be it remembered that the whole country from Bowling Green to Mufordsville is similarly honeycombed.

The chamber called "Wright's Rotunda" is 400 feet one way and 100 feet wide, while its height is 40 feet.

Mammoth Dome, of a similar length, has a roof of 150 feet span, in the sandstone, and its depth from the bottom of the superincumbent sandstone to the floor is 250 feet.

NOTICES OF BOOKS.

Taschenbuch für die Soda, Pottasche, und Ammoniak Fabrikation. (Pocket Book for the Manufacture of Soda, Potash, and Ammonia). Von Dr. G. Lunge. Berlin: Julius Springer.

We have here a book of reference calculated to prove exceedingly useful to a numerous and important class of chemical manufacturers. The author sets out with the intention of supplying a general unity and agreement in the analytical methods used in chemical manufactories, as well as in the atomic weights, tables for reduction, and other numerical constants. The calculations of molecular weights, of percentage compositions, analytical factors, &c., have been carefully verified for the purpose of eliminating errors which in some cases have found their way from one text-book to another. We may venture to say that the value of these re-calculations will, as the work becomes known, find recognition in industrial and technical laboratories.

The work consists of two main portions, the general and the special. In the former we find firstly a table of the atomic weight, the equivalents, and the atomicity of the elements, round numbers being mostly aimed at. We note that the author retains the old atomic weight for platinum (197·18) in preference to 194·46 as established by Seubert, on the ground that the former is universally accepted by the German potash-trade, just as in England the old atomic weight of sodium (24) has been so long maintained in opposition to the true figure. Next follows an exceedingly useful table showing in six parallel columns the molecular formulæ, molecular weights, equivalent formulæ, and weights and percentage composition of 162 compounds, including those most extensively used in manufactures and in analytical operations.

Then follow tables for calculating the results of gravimetric analyses on the same principle as those inserted in "Rose's Quantitative Analysis."

Next we have the solubilities of a number of compounds in cold and in boiling water, and of some of the more common and important salts in water at temperatures ranging from 0° or lower to 100°, and in some cases upwards. We then find Bunsen's table of the solubility of gases at a pressure of 760 m.m., and that of a number of gases at the same pressure, but at a range of temperatures. Then follow the specific gravities of solids, of liquids, the specific gravities and percentages of saturated saline solutions, the volume-weights of gases and vapours, the linear expansion of a number of bodies from 0° to 100°, tables for the conversion of the three thermometer scales, melting-points, boiling-points, tables for the reduction of the volumes of gases to normal temperature and pressure, the volumes of water at different temperatures, the reduction of water-pressure to mercurial pressure, tension of watery vapour, boiling-points of water at different barometric pressures. Next come a set of mathematical tables showing the circumferences and areas of circles, squares, cubes, square- and cube-roots, measurements of certain surfaces and solids, measures and weights of different countries, different values of "horse-power," which appear to range from 474·53 to 600·85 foot-pounds, and values of coins.

Then we come to an abstract of the two laws most important in an industrial sense,—the patent-law (German), and the responsibility of manufacturers for accidents happening to their workmen. We cannot help remarking that the German patent-law contains some provisions which might be usefully introduced into our English system.

The "special" portion of the work is chiefly devoted to the analytical methods needful in examining raw materials, intermediate and finished products, residues, &c. The author has made it his object to select processes sufficiently simple and expeditious for industrial purposes, and at the same time, practically speaking, accurate. Where necessary, the apparatus used is plainly figured.

Under the determination of sulphur in pyrites we note that Dr. Lunge recommends Rieckmann's filter-paper as preferable to Swedish for the filtration of barium sulphate. In speaking of copper pyrites he remarks that the electrolytic method for the determination of the copper has not yet been adopted in copper works, as it has not been found practicable to obtain the copper sufficiently pure by a single precipitation. He recommends the precipitation of the copper as sulphide, with certain precautions, and the ignition of the precipitate, mixed with pure sulphur in a current of hydrogen or coal-gas.

Under sulphuric acid is a table of its specific gravities, with the corresponding degrees of Twaddell and Baumé, at 15° C., and another table, giving the reduction of the specific gravitity of sulphuric acid of different strengths to other temperatures, its freezing-points, boiling-points, also the specific gravity and percentage of fuming sulphuric acid at different temperatures; a table for determining the nitrous acid in nitriferous chamber-acids, &c.; examination of the acid for traces of nitrogen-acids (for which Dr. Lunge utilises the splendid blue colouration produced by the addition of diphenylamine dissolved in 100 parts of *pure* sulphuric acid), lead, iron, and the analysis of fuming acid and of sulphuric anhydride.

Under the manufacture of chloride of lime we find methods for the analysis of natural pyrolusite, of the regenerated manganese and mud of the Weldon process, of chloride of lime, and of the gases obtained by the Deacon process.

An appendix contains instructions for taking samples of ores, minerals, and chemical products,—an operation often sadly mismanaged to the no small injury of the reputation of the unfortunate analyst.

As a convenient and accurate book of reference for all chemists connected with the alkali-manufacture and its associated branches this work is certainly unequalled. It presents in a pocket form information which would require to be sought up from a number of authorities, and with great loss of time. We may add that the paper is good, and the type, though necessarily small, is exceedingly clear.

The Philosophy of Advertising, and Newspaper Register for 1883. By Henry Sell. London: Sell's Advertising Offices.

The author of this work strongly urges upon men of business the policy of advertising, and as decidedly recommends them to do it not directly but through the intervention of an agent. He maintains that incidental advertising is of little value, the results of £500 spent in a year's advertising will be more than double as great as (those of) £250, &c. He maintains that "each paper pays better as it is backed up by other advertisements in other papers," and he refers to "the extraordinary successful result of advertising in religious papers." This result, which we do not dispute, springs doubtless from the very questionable opinion entertained by the many that an advertisement which appears in a religious paper cannot be untrustworthy! The author very judiciously remarks that "advertisements in class papers are always amply repaid." In all cases of articles which appeal to some one class, a paper of relatively small sale read exclusively by that class is more valuable than an ordinary paper of immense circulation. Hence we scarcely appreciate the author's omission of many magazines from his list on the grounds that "some publications do not take advertisements, and others are, for various reasons, useless to advertisers." We doubt whether this latter verdict can justly be passed upon all that are omitted from his list. We find the *Telegraphic Journal*, now published weekly, figuring among the monthlies. *Longman's Magazine*, which has a large advertising connection, does not appear at all. Taken as a whole, Mr. Sell's book will prove of great value to all inclined to advertise.

CORRESPONDENCE.

THE COLOUR OF THE CYANOGEN FLAME.

To the Editor of the Chemical News.

Sir,—The experiment of the burning of cyanogen in air is perhaps one of the most beautiful in chemistry, and the observer may well hesitate before attempting to describe in words the splendid tints of the flame produced; but if the attempt is made, some approach to accuracy of description is desirable. The flame of cyanogen burning in air has been variously called purple (Brande, Turner, Graham, Regnault, Williamson, Roscoe, Harcourt and Madan, and Thorpe), purplish-blue (Thomson), bluish, mixed with purple (Ure), bluish, purple on the edges (Gerhardt), purple on the edges (Wurtz), purple-mantled (Roscoe and Schorlemmer), purple or peach-blossom coloured (Fownes), peach-blossom coloured (Watts), pale red (Fyfe), rose-edged purple (Miller), rose-red (Odling), violet (Armstrong), pink, edged with green (Bloxam), and pink or purplish, edged with yellow (Gregory).

In 1848 the late Professor John William Draper submitted the flame of cyanogen to a critical examination. He first, by the aid of a prism, examined the flame as a whole and mapped out its spectrum; and then, by an ingenious arrangement, examined the flame in detail, and found that for every band in the spectrum there was a zone of similar colour in the flame. Draper next sought to intensify the combustion of the cyanogen by burning it in oxygen in place of in air. As he anticipated, the flame increased in brilliancy, losing its delicate tints of pink and green and assuming a bright yellowish-white.

If carefully dried cyanogen, prepared from pure cyanide of silver, be burnt at a platinum jet it is possible by careful observation with the unaided eye to detect between the apex of the innermost zone of pale rose-lilac and the zone of pea-green, a zone of bright chrome-yellow, and outside, and enveloping all, a mantle of dark indigo-blue. It is a pretty experiment, while the cyanogen flame is being watched, to gently and gradually heat the platinum tube through which the gas passes, and at the end of which is the jet where the gas burns. The tints of rose-lilac and green and blue slowly fade and blend with a yellowish-white which seems to grow up in their midst. On slowly withdrawing the heat the yellowish-white softens and changes again to the rose-lilac and green and blue.

If cyanogen be burnt in a tube through which a current of pure dry oxygen is urged the colour of the flame may be made to change rhythmically from rose and green to yellowish-white by altering the relative rate of flow of the gases.

The experiment of altering the colour of the flame of cyanogen by raising the intensity of combustion has been performed in another way by Morren. With a Frenchman's enthusiasm he thus describes his experiment:—

"Si on fait brûler le cyanogène au moyen du chalumeau à deux courants, en faisant arriver au centre de la flamme du cyanogène un courant d'oxygène très pur (cette condition est indispensable) on voit se produire un des plus beaux effets de combustion possible, et cette expérience est certainement une des plus magnifiques qu'on puisse réaliser sur la combustion des gaz. Il se produit, au milieu de la flamme rosé-violâtre du cyanogène, une boule d'un blanc vert éblouissant qui rappelle la lumière électrique produite par le courant de la pile entre deux charbons de cornue."

Plücker and Hittorf, speaking in more prosaic language, say:—

"When a jet of cyanogen mixed with oxygen is kindled, in the interior part of the flame a most brilliant cone of a whitish-violet light is seen, the limit between the ignited and the cold part of the jet:" and again, if "jets of the two gases meet from opposite sides [they form], if kindled, a brilliant flat vertical surface."

An instructive variation of the experiment of burning cyanogen in air is to cause the flame, by increase of pressure, to detach and maintain itself at a distance from the jet. A pillar of gas is obtained with a pointed head on which fits an envelope of air. Where the pointed head of the pillar rests against the surrounding air combustion takes place, and the red interior surface where the combustion is least intense and the temperature lowest can be clearly distinguished from the outer green or blue surface where the combustion is most intense and the temperature highest.—I am, &c.,

ALFRED W. SOWARD.

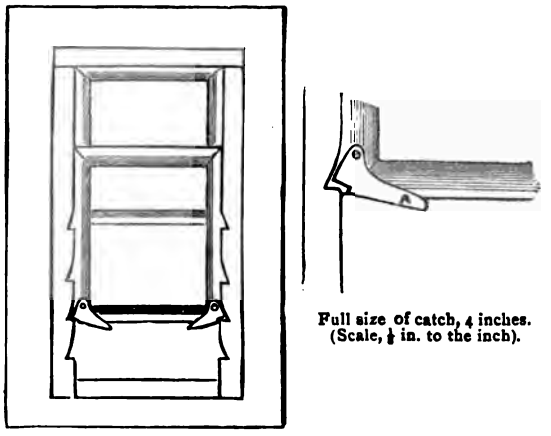
5, Serjeant's Inn, Fleet Street, E.C.

FUME CLOSETS.

To the Editor of the Chemical News.

SIR,—The balance-weights and springs commonly used for the openings of these are a dangerous nuisance, and accidents are constantly occurring. The arrangement I have had in use for several years has now been copied in several laboratories, and has proved so perfectly satisfactory, that a description will no doubt be acceptable to many. The window slides easily upwards, and by preference inside the upper part. On each side is a loose catch of hard wood, preferably boxwood, so shaped that by its own weight it drops into a recess cut in the frame carrying the window. When lifted to any height the catches drop in the nearest recess, and to release them it is simply necessary to take hold of the projections at the point marked A, these projections forming handles by which the window is lowered. It is advisable to have one on each side in case either sticks from dirt or any other cause, although for all practical purposes one is sufficient.

This arrangement has been in daily use for many years without the slightest slip or accident of any kind, whereas, with the balance-weights and springs used previously it



Full size of catch, 4 inches. (Scale, ½ in. to the inch).

was necessary to replace these every few months, and even with every care accidents occurred frequently owing to the rapid and sometimes unexpected destruction of cords or springs by corrosive vapours.—I am, &c.,

THOS. FLETCHER.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 9, February 26, 1883.

Results of a New Series of Experiments on the Appliances for the Transport of Mechanical Energy fitted up on the Northern Railway of France by M. Deprez.—M. Treaca.—An account of experiments made on February 18. The author concludes that a maximum of 50 per cent of the energy generated may be transmitted if certain sources of loss can be corrected.

Formation-Heat of Chromic Acid.—M. Berthelot.—A thermo-chemical paper, not admitting of useful abstraction.

Researches on the Distribution of Dissolved Acids and Bases by the Method of Congelation of the Solvents.—F. M. Raoult.—The general law of the congelation of solvents (*Comptes Rendus*, November 27, 1882) presents, as far as water is concerned, a certain number of anomalies. The author seeks to utilise these in order to find out in what manner a base is shared between two acids, or an acid between two bases. He supposes the case when hydrochloric acid acts upon sodium acetate in equivalent quantities in presence of much water. He finds here that 95 per cent of the acetic acid is set at liberty.

Production of Brominised Apatites and Wagnerites with a Calcium Base.—A. Ditte.—The author has obtained products analogous to wagnerite and apatite in which bromine or iodine is present in place of chlorine, such as calcium bromo-phosphate, brom-arseniate, and bromo-vanadiate.

the slightest trace of either bromine or iodine could be detected.

This analysis is of interest as showing the large amount of saline matter which may exist in a water-weed. Parkes remarks in his "Manual of Hygiene" (p. 30), "It should also be remembered that some water plants have a purifying effect, apparently from the large amount of oxygen they give out: and this takes place sometimes though the water itself is green." It appears probable that aquatic plants possess not only the power of indirectly oxidising dissolved organic matter, but also of removing saline substances from water. When sewerage is placed on the ground, vegetation is encouraged in order to render animal matter innocuous, and there does not appear to be any valid reason why a similar procedure should not be applicable and equally beneficial in the case of contaminated water. The desirableness, therefore, of allowing water-weeds to grow freely in Indian tanks—which are always extremely liable to pollution--need hardly be urged.

But in order to derive benefit from aquatic plants, tanks should be cleaned periodically. The danger of permitting weeds to remain in water during the hot weather is alluded to by Drury ("Useful Plants of India"). He states that "in Jamaica the *Pistia stratiotes*, in the hot dry weather, impregnates the water with its particles to such a degree as to give rise to the bloody-flux." In the hot weather, when the volume of water in a tank is reduced through evaporation, &c., any contaminating material gaining access would be introduced into the system in a less diluted form than when the same tank was full. The object should therefore be to facilitate oxidation as much as possible.

The higher the temperature of the water the more rapid is oxidation likely to be, and a water in the hot weather freely exposed to the action of heat, light, and air, is less likely to retain deleterious organic matter in an active form than the same water covered with a layer of floating vegetation. In the cold weather, on the other hand, when tanks are full, the indirect oxidising power possessed by aquatic plants might be utilised to assist in the destruction of organic matter, and in the removal of inorganic salts which may have been washed into the water by rainfall.

Bearing in mind the exposed condition of most Indian tanks, and the numberless sources of pollution to which they are exposed, it seems probable that it is only on such grounds that the absence of ill effects ensuing in then using the water can be explained. The mouths of wells, in most instances, are slightly raised above the level of the ground, so that, as a rule, contaminating matter has to filter through a certain depth of soil before reaching the water, and is there rendered innocuous, but when sewerage does gain direct entrance it appears to retain its toxic powers for a prolonged period, this being doubtless due to the low temperature of the water, and the more or less absence of light, aquatic plants, and stagnation of the air.

Medical College, January 24, 1883.

Royal Institution.—The following are the the arrangements for the Lectures after Easter:—Professor J. G. M'Kendrick, ten lectures on "Physiological Discovery;" Dr. Waldstein, four lectures on the "Art of Pheidias;" Professor Tyndall, three lectures on "Count Rumford, Originator of the Royal Institution;" Mr. R. S. Poole, three lectures on "Recent Discoveries in (1) Egypt, (2) Chaldæa and Assyria, (3) Cyprus and Asia Minor;" Mr. A. Geikie, six lectures on "Geographical Evolution;" and Professor C. E. Turner, four lectures on "Historical Sketches of Russian Social Life." The discourses on the Friday evenings will probably be given by Mr. A. Geikie, Dr. Waldstein, Professor B. Balfour, Mr. C. W. Siemens, Mr. R. A. Scott, and Professors Huxley, Turner, Flower, Pollock, and Dewar.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING FEBRUARY 28TH, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

March 5th, 1883.

SIR,—We submit herewith the results of our analyses of the 168 samples of water collected by us during the month of February, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 168 samples, two were recorded as slightly turbid, and five as very slightly turbid. The remainder were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from February 1st to February 28th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 24 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Chelsea Water Company, one was recorded as "very slightly turbid." The remainder were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Lambeth Water Company, two were recorded as "very slightly turbid," the remaining 22 samples being well filtered, clear, and bright.

Of the 24 samples from the mains of the Grand Junction Company, six samples were recorded as "very slightly turbid," the remaining 18 samples being found well filtered, clear, and bright.

Of the 24 samples from the mains of the Southwark and Vauxhall Company, two were recorded as "very slightly turbid," the remaining 22 samples being found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

The proportion of organic matter found in the water has continued to be much the same as that observed during the previous month; although the maximum amount found in one particular sample taken in January has not since been met with. The condition of the water in respect to its freedom from turbidity has been noted in the preceding paragraphs.

We have the honour to remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE

USE OF LITMUS, METHYL-ORANGE, PHENACETOLIN, AND PHENOL-PHTHALEIN AS INDICATORS.*

By ROBERT T. THOMSON.

(Concluded from p. 127).

XI. *Effect of Silicate of Sodium.*

A PRELIMINARY test was made of the value of litmus for the estimation of soda in silicate of sodium by taking a quantity of hydrate of sodium of known strength, dissolving some silicate in it, and then determining the soda. The exact amount of soda used was found, and the estimation made by litmus was taken as the standard of comparison with the results obtained with the other indicators. 5 grms. of commercial liquid silicate of soda were employed, and 15·05 c.c. of normal acid were consumed with litmus as indicator, the end-reaction taking place with great distinctness.

With *Methyl Orange*, also, a very distinct end-reaction was obtained, and 15·1 c.c. were consumed, a result closely corresponding with the former one.

Phenacetolin gives a dark pink colour with the silicate of sodium, but this became yellowish towards the end of the test, and the change was not very distinct. 15 c.c. of the acid were necessary, which does not materially differ from the quantities obtained with litmus and methyl-orange.

Phenol-phthalein.—The red colour produced by the phenol-phthalein was slowly destroyed on running the acid into the cold silicate solution, 12·7 c.c. only being required. When boiled, the colour returned, but was dispelled when 13·5 c.c. had been added. These results are considerably below the truth.

TABLE VIII.

Results obtained in the titration of silicate of sodium ($Na_2Si_4O_9$).

Name of Indicator.	C.c. Normal Acid consumed.	Grm. of Na_2O found.
Litmus	15·05	0·466
Methyl-orange	15·1	0·468
Phenacetolin	15·0	0·464
Phenol-phthalein (cold) ..	12·7	0·393
,, (boiled)..	13·5	0·418

XII. *Effect of Alumina.*

Soluble alumina, like silica, is seldom or never absent from caustic soda or potash. The experiments were made with an excessive quantity of alumina, the proportion used being equal to about 8 per cent in an average strength caustic soda. A quantity of pure hydrate of aluminum, equal to 0·515 grm. Al_2O_3, was prepared from alum by precipitation with ammonia. This precipitate was redissolved, re-precipitated, washed thoroughly, dissolved in 125 c.c. of normal caustic soda, and made up to 250 c.c. with water. 50 c.c. of this was employed for each test, and contained 0·775 grm. of soda, and 0·103 grm. of alumina.

Litmus.—When litmus was used 25·25 c.c. of the normal acid were consumed in place of 25 required when no alumina was present, nor did the end-reaction come out very distinctly.

Methyl-orange.—After a little more than 25 c.c. of the acid had been consumed, the alumina was all precipitated, and then gradually dissolved, the pink colour at first produced being quickly dispelled as the acid combined with the alumina. A decided and permanent change occurred when 30·7 c.c. had been added. This gives 0·951 grm. of soda as against 0·775 really present, and if the difference be calculated to alumina, it shows 0·097 grm. of the latter compound instead of 0·103. It is thus evident that nearly the whole of the alumina has been estimated along with the soda.

With *Phenacetolin* and *Phenol-phthalein* the real amount of soda used was obtained. The only effect of the precipitated alumina is to obscure the end-reaction slightly.

TABLE IX.

Results obtained in the titration of aluminate of soda.

Na_2O used for each test	0·775 grm.
Al_2O_3 ,, ,, ,, ...	0·103 ,,
$=Na_2O$,, ,, ,, ...	0 186 ,,

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of Na_2O found.
Litmus	25·25	0·782
Methyl-orange ..	30·7	0·951
Phenacetolin	25·05	0·776
Phenol-phthalein ..	25·0	0·775

XIII. *Effect of Nitrite of Sodium and Potassium.*

A solution of nitrite of potassium was prepared by decomposing with chloride of potassium a known weight of nitrite of silver, which was precipitated from a solution of nitrite of sodium. 20 c.c. of this nitrite of potassium liquor contained 1·7 grm. of KNO_2, and this quantity diluted to 100 c.c. was employed for each test. The nitrite was found to be quite neutral to litmus, phenacetolin, and phenol-phthalein. With methyl-orange, however, the pink colour was not produced, even after adding 30 c.c. of normal acid, but seemed to be destroyed at once by the liberated nitrous acid. Another quantity containing 0·085 grm. of the nitrite in the 100 c.c. gave a pink colour with 0·2 c.c. of acid, but this was slowly dispelled on standing a few minutes, leaving a pale yellow colour. Nitrite of sodium acts in the same way towards the indicators as nitrite of potassium. Nitrites are sometimes found in small proportion in caustic soda and potash.

XIV. *Determination of Soda in Borax.*

The solution of borax employed contained 1·683 grms. of pyroborate of sodium in 50 c.c., the quantity used for each test.

With *Litmus* the blue colour began to purple when 13 c.c. had been added, but the change was not complete until 16·65 in the one case and 16·6 c.c. of normal acid in the other had been consumed. This shows 0·516 and 0·514 grm. of soda, as against 0·516 really present. The end-reaction, however, is very indistinct.

Methyl-orange is by far the best indicator for the estimation of soda in borax, and is, indeed, perfect in that respect. The change in colour at the end of the experiment was very sharply defined. The results agreed closely with those of litmus.

Phenacetolin.—Like litmus the colour of this indicator slowly changes, and a good end-reaction is therefore impossible. The whole of the soda can be estimated by it.

Phenol-phthalein is utterly useless for the purpose under consideration. The red colour disappears before half of the soda is determined in cold solutions. When boiled a much higher result is obtained, but still very far below the truth.

TABLE X.

Determination of Soda in Borax.

$Na_2B_4O_7$ used for each test	1·683
$=Na_2O$,, ,, ,, ...	0·516

Name of Indicator.	C.c. of Normal Acid consumed.	Grm. of Na_2O found.
Litmus	16·65—16·6	0·516—0·514
Methyl-orange..	16·7 —16·65	0·518—0·516
Phenacetolin	16·7 —16·6	0·518—0·514
Phenol-phthalein (cold)..	7·6 — 7·8	0·235—0·242
,, (boiled)..	11·0 —11·3	0·341—0·350

* A Paper read before the Philosophical Society of Glasgow (Chemical Section), January 22, 1883.

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THE CHEMICAL NEWS.

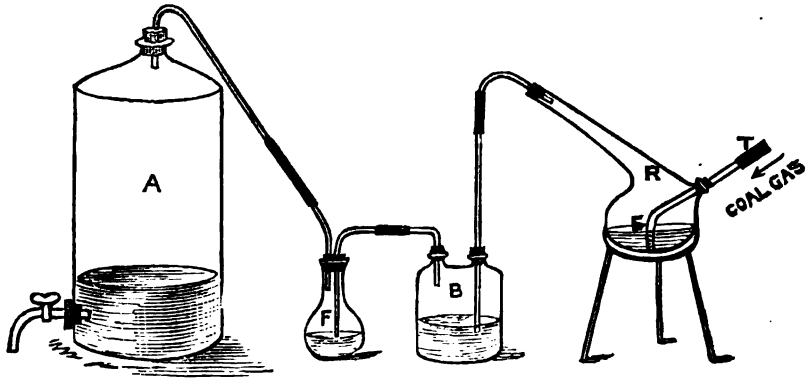
Vol. XLVII. No. 1218.

PREPARATION OF HYDROGEN SULPHIDE FROM COAL-GAS.

By I. TAYLOR, B.A., Science Master at Christ College, Brecon.

Hydrogen sulphide may be prepared very easily, and sufficiently pure for ordinary analytical purposes, by passing coal-gas through boiling sulphur. Coal-gas contains 40 to 50 per cent of hydrogen, nearly the whole of which may, by means of a suitable arrangement, be converted into sulphuretted hydrogen. The other constituents of coal-gas—methane, carbon monoxide, olefines, &c.,—are not affected by passage through boiling sulphur, and for ordinary laboratory work their removal is quite unnecessary, as they do not in any way interfere with the precipitation of metallic sulphides.

A convenient apparatus for the preparation of hydrogen sulphide from coal-gas—such as we have at present in use in the Christ College Laboratory,—consists of a retort, R, in which sulphur is placed. Through the tubulure of the retort there passes a bent glass-tube, TR, perforated near the closed end F with a number of small holes. (The perforations are easily made by piercing the partially softened glass with a white-hot steel needle—an ordinary crotchet needle, the hook having been removed and the end sharpened, answers the purpose very well). The end



T of the glass tube is connected by caoutchouc tubing with the coal-gas supply—the perforated end dipping into the sulphur. The neck of the retort—inclined slightly upwards to allow the condensed sulphur, as it re-melts, to flow back,—is connected with a wash-bottle, B, to which is attached the flask, F, containing the solution through which it is required to pass the hydrogen sulphide; F is connected with an aspirator, A.

About one pound of sulphur having been introduced into the retort and heated to the boiling-point, the tap of the aspirator is turned on and a current of coal-gas drawn through the boiling sulphur; the hydrogen sulphide formed is washed by the water contained in B, passes on into F, and finally into the aspirator. The speed of the current may be regulated by the tap, and as the aspirator itself acts as a receptacle for excess of gas, very little as a rule escapes into the room, and consequently unpleasant smells are avoided.

This method of preparing sulphuretted hydrogen will, I think, be found useful in the laboratory. It is cleanly, much cheaper than the ordinary method, and very convenient. During laboratory work, a burner is placed under the retort and the sulphur kept hot, so that its temperature may be quickly raised to the boiling-point when the gas is required. From time to time it is necessary to replenish the retort with sulphur and to remove the condensed portions from the neck.

ON THE HYDRATE OF CHLORINE.*

By Professor E. MAUMENÉ.

The note of M. Ditte compels me to publish the experiments which I made a long time ago upon this substance, the composition of which is not singular. The hydrate formed at about 5° by the rapid passage of a current of chlorine is generally of a pale colour, differing little from that of the solution. If the crystalline matter, after being drained in a funnel, is slightly compressed between folds of filter-paper, and is submitted to analysis, we always find a little more than 12 equivalents of water to 1 of chlorine. Faraday obtained 10 equivalents: I shall immediately say wherefore. If we enclose the hydrate—the formula of which I have just given—after being drained and pressed between paper in a bent tube, according to the directions of Faraday for obtaining liquid chlorine, we may easily see in the part of the tube bordering upon this liquid the appearance of crystals much more deeply coloured than those of the solution, and much less laminated than the foregoing. These crystals are produced and persist as long as the solution of chlorine in the main limb of the tube is hot enough not to admit of an absorption of chlorine. Their composition varies. If they are formed in presence of a sensible excess of liquefied chlorine they present the composition $Cl(HO)_4$. But if they are close to the solution, and especially if they are dissolved in the tube by causing a little of the solution in the large limb of the tube to pass into the smaller limb, taking care to keep the large limb the hotter of the two, they may be reproduced by a slight and gradual refrigeration of the smaller limb, with a variable composition, but bordering upon $Cl(HO)_7$.

These three results were predicted by my theory.

Chlorine, when in presence of a weight of water differing little from its own, can combine with an equal weight, or 36. These conditions are realised in the small limb of the apparatus; when the crystals are formed in the vicinity of the liquefied chlorine we obtain $Cl(HO)_4$. These crystals appear to me cubic, and such as M. Ditte has just described them. When, on the contrary, the water is in excess, the $Cl(HO)_4$ combines with a weight of $72=8HO$, and forms crystals octahedral, but still orthorhombic, the surfaces of which present very unequal

* Communicated by the Author.

developments. These crystals, of a colour almost identical with that of their solution, contain 12HO, and it is even common to obtain 12·1 and 12·2, because it is very difficult to dry these bodies, even with a patience which the cold renders rather painful. Lastly, as the theory indicates, the two hydrates $(HO)_4$ and $(HO)_{12}$ may combine together in equal weights, and the result is—

$$\frac{Cl(HO)_{12}\ \text{combines with}\ 2Cl(HO)_4}{\frac{35{\cdot}5\ \ 108}{143{\cdot}5}\qquad\qquad\frac{35{\cdot}5\ \ 36}{71{\cdot}5\times 2=143.}}$$

The compound thus formed is $Cl_3(HO)_{20}$ or $Cl(HO)_{6\cdot67}$. It will be understood that the analysis gives figures bordering upon $(HO)_7$. Chemists who have paid some attention to my theory will comprehend without trouble how Faraday has obtained a mixture $Cl(HO)_{10}$. I think it needless to dwell on this point. As M. Ditte has given no numbers I hope that the present note may aid him in completing his study, and I await with absolute confidence the confirmation of the results which have just been given. The theory has hitherto not received the slightest contradiction from an age of exact experiment.

ON SOME COLOURING MATTERS BELONGING TO THE ROSANILINE SERIES.

By RAPHAEL MELDOLA.

(Continued from p. 133).

(Additional Note).

A naphthylated derivative of rosaniline analogous to diphenylamine blue is produced by heating β-naphthyl-phenylamine—

$$N\begin{cases}C_{10}H_7\beta\\C_6H_5\\H\end{cases}$$

with oxalic acid or any of the oxidising substances which transform diphenylamine into its blue. After purification the colour can be made into a sulphonic acid, which dyes of a greenish shade of blue far beyond diphenylamine blue in green *nuance*, but not quite so brilliant as the latter on silk or wool. α-naphthyl-phenylamine does not readily yield a blue by the action of oxalic acid, nor is any colour obtained by this means from di-α-naphthylamine or di-β-naphthylamine.

None of the colouring matters described in these notes have as yet been submitted to detailed scientific examination, but as they may be of technical use I have thought it advisable to make known their existence in anticipation of further work upon the aromatic derivatives of methane.

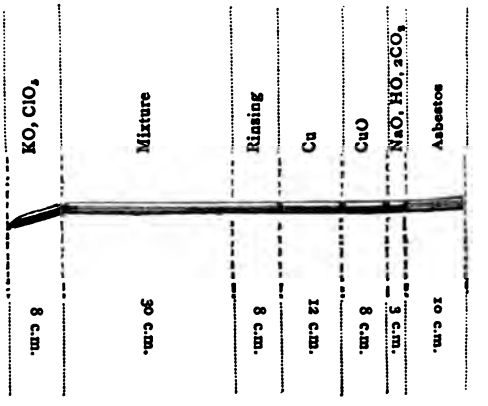
ON THE DETERMINATION OF NITROGEN IN ORGANIC BODIES.

By S. W. JOHNSON and E. H. JENKINS.

For the volumetric determination of nitrogen the authors use a modification of the process of Dumas, by which they have obtained good results. Whilst generally the nitrogen is driven by carbonic acid into the measuring cylinder, they collect the gas in a Schiff's apparatus by means of a Sprengel's mercurial pump. The combustion tube is about 70 c.m. in length, but bent downwards at its farther end, as shown in the figure.

This end is charged with potassium chlorate, then follows the mixture of the substance with copper oxide and the copper oxide used for rinsing the interior of the tube: then a stratum of metallic copper; then granular copper oxide and a little sodium bicarbonate. The front of the tube is filled with asbestos, and the strata, as shown in the figure, are separated by asbestos stoppers. Before beginning the combustion the tube is thoroughly evacuated with the mercurial pump, observing if the connections are air-tight. The small layer of sodium bicarbonate is then first heated so as to fill the combustion tube and the descending tube of the pump with carbonic acid. The gas-tube of the pump is then conveyed into the collecting apparatus, so that it opens under the mercury junction. The combustion is then carried on in the ordinary manner, the potassium chlorate being heated last when the escape of gas has almost ceased. The oxygen thus liberated completes the combustion of the organic matter, and re-oxidises the reduced copper. The rather long stratum of metallic copper prevents the entrance of oxygen into the collecting apparatus. As soon as the oxygen distinctly oxidises the stratum of copper its evolution is stopped, and the pump is set in motion. The gas is thus completely passed into the measuring tube, and the mercury escapes from the lateral aperture of the collecting apparatus.

Max Gruber proposes also a modification of the method of Dumas. He takes a combustion-tube of 95 to 100 c.m. in length, draws it out to a point at the hinder end, and fills it as follows:—An asbestos stopper, 25 to 30 c.m. sodium bicarbonate, an asbestos stopper, 8 c.m. of granular copper oxide, an asbestos stopper, the mixture of the substance with finely granular copper oxide (about 12 c.m.),



a rinsing with powdered copper oxide, 8 c.m., an asbestos stopper, a stopper of copper-wire gauze, 8 c.m. of granular metallic copper, a stopper of copper-wire gauze, 8 c.m. copper oxide, and lastly an asbestos stopper.

At the outset Gruber passes through the tube carbonic acid from a Kipp's apparatus to expel the air; fuses up the drawn-out end of the tube, and evolves carbonic acid by heating a part of the sodium bicarbonate. The combustion is conducted as usual, and finally all the gas is driven into the measuring cylinder by heating the rest of the sodium bicarbonate. After the absorption of the carbonic acid the measuring-cylinder is placed in water which has been boiled, and the volume is read off.

Gruber compares the results of this process with those of Varrentrapp and Will's method. He shows that besides the nitro-compounds there are others whose nitrogen cannot be determined by heating with soda-lime, and he admits that such bodies may possibly be found among the albumenoids. For the substances which he examined —meat and peas—he finds the Varrentrapp-Will method perfectly available.

Gruber does not find the precautions suggested by Makris—ignition at a low temperature and the addition of sugar—at all needful.

Gassend and Quantin give results on the soda-lime process which are in complete opposition to those of Gruber. They maintain the results of the analysis depend very closely on the quantity of the substance taken, the length

of the tube, and the duration of the process. They recommend to take so little of the substance that the ammonia may not neutralise more than half of the acid: they select a tube not longer than 40 c.m., and they conduct the process so quickly as not to last more than thirty minutes.

Instead of determining the residual acid by titration, or of precipitating the ammonia as platinum chloride, Mohr evaporates the acid (hydrochloric) to dryness, and determines the chlorine with silver solution in the usual manner.

For determining the nitrogen in hair, wool, &c., Krauch treats with sulphuric acid, neutralises excess of acid with calcium carbonate, and thus obtains a mass which can be readily pulverised.—*Zeitschrift für Analytische Chemie*, xxi., p. 274.

ON THE PRESSURE OF SATURATED VAPOUR OF MERCURY.

By H. HERTZ.

The following determinations of the pressure exerted by saturated mercurial vapour were made in the course of the author's experiments on evaporation. In computing the latter he made use at first of the figures given by Regnault, but they were evidently unsuitable. If the results obtained according to the second method were tabulated in such a manner that for a given temperature of the surface the quantities evaporating in a unit of time were represented as abscissæ and the accompanying pressures as ordinates, series of points were obtained which approximated very closely to straight lines. If these lines were produced even very little beyond the observed interval those pressures were found which corresponded to the evaporation null, and must consequently represent the pressure of saturation. The numbers thus found were all smaller than those of Regnault. That the explanation of this circumstance must be sought for in errors of the latter seemed probable in consequence of the experiments of Herr Hagen, but the values which he found deviated also from the right lines obtained. Hagen himself conjectured that his values were too small for temperatures above 100°, which came more especially in question.

The author describes these experiments with reference to two diagrams, and proceeds:—

As for the calculation of these experiments, I have attempted to apply to them a formula not yet used for this purpose. It is theoretically justifiable, and must be correct with the same degree of approximation with which the saturated vapour follows the law of Gay-Lussac and Mariotte for highly rarefied vapour. Supposing the validity of this law, the vapour has a constant specific heat at a constant volume. Let it be c, let s be the specific heat of the liquid, and ρ_T the internal evaporation-heat for the absolute temperature T. Then, on the supposition made, $\rho_T = \text{constant} - (s-c)T$. This proposition is proved by conceiving a quantity of liquid of the temperature T, brought to any other temperature, converted into vapour without external work, and such vapour, still without external work, brought back to the temperature T and precipitated. In this process the liquid can neither have received nor given off heat. On the other hand, according to the mechanical theory of heat, we have—

$$\rho_T = A u (T\, dp/dT - p),$$

where p denotes the pressure of the saturated vapour, and u its specific volume; consequently $u = RT/p$. If we eliminate ρ_T and u from the three above given equations we have a differential equation for the curve of vapour-tension, which gives the following integral:—

$$P = k_1 T^{1-\frac{s-c}{AR_e}} e^{-\frac{k_2}{T}}.$$

For mercury s is known. Winkelmann, from his own experiments and from a statement of Regnault's, finds a slight decrease for this magnitude at increasing temperatures, and as a mean value between 0° and 100° $s = 0{\cdot}0330$. Experiments performed by Dr. Ronkar in the Physical Institute here show that the change between −20° and +200° is exceedingly small, and give the mean value $s = 0{\cdot}0332$. This value is introduced into the calculation. The quantity c is found by the consideration that according to the results of Kundt and Warburg the relation of the specific heats for mercury vapour = 5/3, and it is found = 0·0149. Hence the exponent of T appears as − 0·847. The two remaining constants are determined by observation. The constants thus determined are subjected to a correction, in which it is rational to assume the observations of pressure as correct, and therefore to reduce the sum of the squares of the errors of temperature to a minimum. In this manner the author finds $\log k_1 = 10{\cdot}59271$ and $\log k_2 = 3{\cdot}88623$. If these constants are introduced into the formula, and if it receives a form more convenient for calculation, it becomes

$$\log p = 10{\cdot}59271 - 0{\cdot}847 \log T - 3342/T.$$

The author gives a table of the pressure of the vapour for every 10 degrees from 0° to 220°. At 0° it is 0·00019, at 100°, 0·285; at 200°, 18·25; and at 220°, 3490.

It must be remembered that p becomes = 0 at $t = -273°$, and that the formula for the internal latent heat of the vapour gives the value $\rho_T = 76{\cdot}15 - 0{\cdot}0183T$. The numbers given above deviate not inconsiderably from those both of Regnault and of Hagen. They are, throughout, smaller than those of Regnault, but approach nearer as the temperature rises, and coincide with them near 220°. They are greater than Hagen's numbers above 80° (100°?), coincide almost with them between 80° and 100°, and are smaller below 80°.

The chief interest attaches to the pressure of the vapour at the ordinary temperature of the air. According to the results of these investigations it is less than the thousandth part of a millimetre. A correction for this pressure cannot therefore be introduced in reading the indications of the barometer and manometer. The smallness of the pressure in question, rather than any particular property of mercury, is probably the cause of the vanishing influence which the mercurial vapour always present exerts upon the discharge phenomena in Geissler's tubes.—*Wiedemann's Annalen*, 1882, p. 193.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, F.G.S., late R.A

(Continued from p. 79.)

XI. Boric Acid and Aluminium Plate (*Continued*).

Is the Silica Compound a Compound of Hydrogen?

For the use of those readers who may not have followed my "Notes" IX. and X. in the Chemical News, vol. xlvii., pp. 28, 78, I will now collect the facts mentioned in those articles, as follow:—

A. Pure chemically-prepared *silica*, or powdered rock-crystal, is utterly unattacked and unchanged in boric acid before the blowpipe: the bead remaining clear.

B. *Calcium Pyroborate* (formed as described in note IX.) is also unattacked and unchanged under similar conditions: the bead remaining clear.

C. But when the former is dissolved in the latter (as A, B), or the latter added to the former (as A+B), and treated in boric acid before the blowpipe, a remarkable change takes place; in both cases attended with the emission of a large quantity of *opaline matter*—proved to emanate from the silica (A)—into the clear bead, rendering it and successive beads opaque.

D. In the case of A, B, notwithstanding A's loss of

opaline matter, the compound A B is much heavier than it was before this loss, in consequence, evidently, of an absorption of boric acid from the containing bead; and it was proved (in note IX.) that A alone effected this absorption through B, *exchanging*, in fact, the substance causing opalescence in the containing boric acid bead, *for a heavier equivalent* of boric acid, supplied by the bead itself.

E. In the case of A+B, no exchange takes place, but the opalescence-causing substance is simply extracted from A through some force or influence exerted on it by B; which latter remains unchanged in weight, and seems merely to transfer the substance extracted from A to the containing boric acid bead. A's loss, therefore, in this case, is direct and uncompensated, and seems, by several experiments made in 1880, to be very considerable, viz., about three-fifths, or 60 per cent.

I trust I have now made this matter pretty clear to those who have honoured me by their attention, without much confusion, which it is difficult to prevent in the absence of illustrative experiments, because I wish to submit to them my reasons for attributing this opalescence-causing substance (to be called afterwards for brevity, H) to some compound of hydrogen, for which purpose it will be necessary to cite here, some more facts.

F. *Freshly calcined lime*, applied to boric acid before the blowpipe, affords an interior mass or ball, *four times* the weight of the lime (1). *Hydrated lime*, gently dried, and similarly treated, affords a ball *three times* the weight of the calcium hydrate (2). *Pure marble*, or *calcite*, similarly treated, affords a ball *twice* the weight of the calcium carbonate (3).

F(1) causes no opalescence to the containing bead of boric acid; F(2) and F(3), on the contrary, render the bead, in each case, opaque with opaline matter, and, as I have before mentioned in these notes, the calculation based upon the difference of weight between F(1) and F(2), gives to—

Calcium hydrate a percentage of CaO, 75·0; H_2O, 25·0.
By calculation of chemical equivalents calcium hydrate has a percentage of CaO, 75·7; H_2O, 24·3.

(It is a notable fact that in calcium pyroborate the percentage is CaO, 25·0; B_2O_3, 75·0 so that what is termed water has here nearly the equivalence of lime, and lime that of boron trioxide.

There can be no possible doubt here, then, that the opalescence in the case of calcium hydrate, treated in boric acid before the blowpipe, is *entirely due to the combined or chemical water* present in the hydrated lime, which is "exchanged for a heavier equivalent of boric acid, supplied by the bead," precisely as the substance evolved from silica, and causing opalescence in boric acid before the blowpipe, is exchanged in fact (D.)

If I can now show that freshly-calcined lime (affording no opalescence in boric acid before the blowpipe) can be hydrated so as afterwards to afford opalescence when treated in boric acid before the blowpipe, *by means of the opalescent matter derived from pure silica or rock crystal*, I think you and the chemist readers of the CHEMICAL NEWS will admit that I have proved my case. This can apparently be done as follows:—1. A red-hot boric acid bead, which has been rendered quite opaque by means of the pyrological treatment of A, B, or of A+B (it is quite immaterial which), is taken upon a *larger* fragment of pure lime, which has been strongly calcined in O.P. held in a platinum wire rolled round it, and the lime and opaque boric acid bead together are then exposed to the heat of a blowpipe pyrocone (O.P.) from a heated gas apparatus, the blast being propelled by a powerful foot blower. The immediate effect of this is that the lime fragment at first emits intense white light, and gradually *clarifies the opaque bead*, which sticks to it, and it then does not glow quite so strongly, when this part of the operation must be stopped. 2. The fragment of lime is now crushed to coarse powder, care being taken not to mix with its powder any part of the boric acid bead, and a little is immediately applied to a fresh, clear bead of boric acid O.P., when *opalescence is at once communicated to the bead by the freshly-calcined lime*, showing that it has now been hydrated.

Assuming, then, as a proved fact that this peculiar grey opalescence communicated to clear beads of boric acid before the blowpipe denotes the presence of combined water, we at once obtain in the former phenomenon a very useful and important test for the presence of the latter, even approximating to quantitative results. For instance, if we dip a red-hot bead of pure boric acid into distilled water, the bead becomes crystalline and opaque, but only on the surface: when it is held for a minute or so, in O.P. the bead fuses, emits bubbles evidently of steam, and becomes perfectly clear and transparent again, so that water of crystallisation passes off from it by heat, without decomposition. But if we now acidulate the water with nitric, hydrochloric, or sulphuric acid, dip the red-hot bead in the mixture, and fuse it again in O.P., it immediately exhibits permanent grey opaline matter on cooling (combined, or "chemical" water). I find that the powder of minerals containing over 10 per cent of this combined water renders the whole of an ordinary-sized bead of boric acid quite opaque before the blowpipe.

Alkaline Reagents on Aluminium Plate before the Blowpipe.

When we fuse soda or potash (Na or K carbonate) on platinum-foil before the blowpipe, as in the case of testing for manganese, the melted reagent spreads out as a thin pool over the surface of the metal, and sticks to the latter so tenaciously on cooling that from the first result it is difficult to get proper reactions out of such a thin crust of reagent, and from the second, almost impossible to clean your platinum except by boiling it in water. If we similarly fuse these reagents on a stick of charcoal as a support, they sink when melted into the pores of the coal, and are lost to sight altogether.

Now these reagents immediately *assume the spherical shape* when fused before the blowpipe on bare aluminium plate, in consequence of its heat-conducting capacity before described, because this capacity *isolates* the heat upon the assay, *every particle* of which is consequently rendered fluid, and so enables the whole mass to assume sphericity, in obedience to the laws of gravitation and cohesion. The fluid red-hot bead rotates rapidly in O.P., precisely as a bead of borax does on platinum wire; being thus as susceptible of oxidation, and, of course, far more of reduction in H.P. as the latter. When cool, the round ball does not stick to the plate at all, but may be taken off by ordinary pliers. The advantages of this fact are too numerous to mention here: they will doubtless present themselves at once to your pyrological readers, but I may just conclude this paper by one illustration.

The presence of iron in a sulphide may be detected very rapidly by fusing the powder (after roasting it in O.P.) with potash on bare Al plate in a long P.P., when the smallest proportion exhibits a *pink coloured* ball or bead; any sulphur present only forming a reddish brown hepatic bead after heating in H.P. Plattner, I think, mentions that iron oxide is very soluble in soda B.B., but from this very cause it disappears with its alkaline reagent into the charcoal and "makes no sign"!

Combination of Free Hydrogen with Ethylene.—M. Berthelot.—The author formerly succeeded in combining free hydrogen at a dark red heat with the hydrogen carbides, and especially with ethylene, but the reaction was limited by the decomposition of the hydrides in virtue of a true dissociation. In these experiments, conducted at about 550°, only 51 per cent of the ethylene was transformed. On operating at a lower temperature he has since succeeded in extending the conversion to 70 per cent, and in preventing the formation of secondary compounds.—*Bull. de la Soc. Chim. de Paris.*

EXPLOSIVE AND DANGEROUS DUSTS.*

By PROF. T. W. TOBIN, C.E., Ph.D.,
Of the Polytechnic Society, Kentucky.

DURING the month of May last I was honoured with an invitation to address the Kentucky Miller's Association on "Flour Explosions." Being a subject in which I had for many years been interested, I cheerfully undertook the preparation of a lecture, with illustrations. The experiments, although not new, for chemists well know the combustible nature of organic dust in a finely divided condition, yet so impressed my audience that I was more than repaid, on my part, in their interest and applause for the small amount of labour expended. In preparing that lecture there appeared to me certain conditions governing the combustible state of flour which hitherto had been passed by in investigating the appalling catastrophes that from time to time befall our national industries, in the form of mill fires and explosions. Many of my suggestions, the outgrowth of subsequent experiments, have been received with favour; and my theories, if such I may presume to term them, have had the endorsement of practical men before whom they have found their way. The desire to prosecute the truth, which is implanted in every scientific mind, has led me further, and I am here to report progress and court your criticism.

Dust Under the Microscope.—Let us together, then, retrace the narrative of these researches. I will first call into requisition that wonderful instrument that science plunges into the mysterious and opens out its inner secrets to the light of day—the microscope. As it would be difficult to show you individually the objects that I employ as illustrations, I made careful drawings and photographs of them, and by means of a powerful oxyhydrogen light will project magnified images of these upon the disk now before you. (*The lecture room was here darkened and the subsequent microscopic illustrations shown on a screen, magnified to many million times the size of their originals*).

1. I take first some ordinary flour, commonly known as "*Graham meal*," and we find that it consists of quite a miscellaneous gathering of various bodies. There are present: (1) the skins of the wheat-berry; (2) the hairs or "beard;" (3) cells of gluten, a wax-like substance, being the most nutritious portion of the grain; and lastly, (4) the starch in various sized granules. This body forms the bulk of ordinary flour and flour-dust. Now, in order to understand intelligently the natural placement of these parts of the wheat grain, I will bring magnified images of that body.

2. This shows: (1) the beard; (2) the skins, three in number, that enclose the internal starch or gluten; (3) at the bottom there will be noticed the germ, and contiguous with it the crease. Now, the first operation of the miller who has recourse to the newer processes of reduction, is to clean by brushing or agitation, the whole surface of the grain for subsequent operations, and secondly, to break open this crease and get rid of the germ and incidental impurities that are usually there. In so doing a small amount of flour is made, but being charged with impurities, is blown into the dust-room. There are then two classes of dust: 1st, wheat dust, obtained from cleaning the surface of the grain, and 2nd, the refuse flour dust discarded, because being mixed with germ and other foreign matter. Although in my investigations I found two separate channels and outlets, the character and condition of both classes of dust therein were almost identical in physical properties.

3. This will show by a section of the grain the disposition of the parts already described.

4. Pure starch granules, as found in "arrowroot." This may be taken as the typical element in flour dust. We mark the compact spheroidal form of the granule. At a temperature of 140° F. in water it swells, bursts, and is converted into the well-known pasty mass used in the arts. In common with most organic matter, starch is combustible, and contains normally about 18 per cent of water.*

This amount varies, and exposed to a dry atmosphere, may be considerably reduced. I take it as a rational deduction that the most rapid combustion of flour, attended with explosive violence, would occur when freed from moisture. The individual granules burst simultaneously, and the disturbance thus produced bringing new supplies of oxygen, would instantly determine the rapid consumption by fire of the entire mass. This fact will be discussed further on.

5. Immediately following the starch granules we have a quantity of dust obtained from the club moss, called "lycopodium." It is the seed or spore of that plant. Notice the near resemblance in size and structure to the starch granule; but it differs in one respect in being of an oily nature, which (as our experiments will presently convince us), renders it very inflammable.

6. This is highly bolted flour, and as the microscope shows, freed from the husk, the beard, and even the gluten of the wheat, leaving nearly pure starch. We observe that there are three distinct qualities of the granule: (1) the giant; (2) the medium; and (3) the farina, or starch powder.

7. This view will give a fair idea of what change takes place in starch on submitting it to a heat of over 140°; in other words, it is cooked flour. The granules have all disappeared, and in their place are irregular masses of amorphous "dough" or "paste."

8. Some dust collected from the "wheat dust room" shows starch, husk, fractured gluten cells, the beard, and other impurities; it also contains, generally, "fungi," or "smut." The dry and oily nature of this dust renders it more inflammable than starch.

9. Wood abrasions from an axe-handle factory, showing the fibrous and cellular texture of the minute particles of dust. This material is inflammable owing to its extreme dryness.

Combustion.—I will now as briefly as possible lay down the principles that are generally acknowledged by chemists as underlying the phenomena of combustion in organic bodies and apply them to the special instances under consideration. The substances which we will now deal with consist of three elements: oxygen, hydrogen, and carbon. Although in variable quantities the oxygen and hydrogen are always in the ratio of water, *i.e.*, eight parts by weight of the former to every one part of the latter, heat is capable of determining their union and water is the result. Carbon or charcoal is thus left, and being incapable of existing in any but a solid condition, soon stifles further combustion. If, however, oxygen be added, either from the air or as a gas, perfect consumption of the body takes place. We know that a piece of wood, if an insufficient supply of air is present, can only become charred by the most intense heat known. This is the first principle that I will now endeavour to illustrate.

Experimental Demonstration.—Here is some hydrogen in a tube; it is very much the same as that burning from the lamps in the room. I plunge a lighted taper into it, and the taper is incapable of burning for lack of oxygen or air. Hydrogen, although a highly combustible body, will prevent combustion, and even suffocate this burning taper. I now add some air, neither in itself explosive nor combustible, and then heating the mixture, I get a deafening report. Beyond all question I have generated an explosive body.

Then I will take some flour, and perhaps I should tell you that, like the hydrogen when free from free oxygen or air, it is incombustible. Flour thrown on the glowing furnace will retard and even, if sufficient in quantity, extinguish the fierce fire. Like hydrogen alone, it is a non-supporter of combustion. Observe, I plunge a burning taper in this

* An Address read before "The Fire Underwriters' Association of the North-west," at Chicago.

* Miller's "Elements of Chemistry."

measure of flour, and, as you would predict, the taper goes out. Here is a substance, chlorate of potash, which is very rich in oxygen, and I cannot alone make it burn, as you may see. Two harmless bodies I mix; the essentials of combustion are supplied and brilliant fire is the result. Oxygen gas, always present in the air, an exceedingly active and corrosive body, is then the one thing needed to render these inert bodies combustible, and even explosive.

Moisture.—Water, in all its forms, is opposed to combustion, and its presence modifies the rapidity with which the consumption takes place. It is, I think, hardly necessary to illustrate this as a general principle, although in the sequel we shall find in it an element of great importance.

Now, it is by these simple principles that combustion in its varied phases, from the slow decomposition and decay of the green vegetable to the explosion of the modern flour mill, is governed. By the modification of them I think I can show you some interesting results.

Wood Dust.—Here is some dust from an axe-factory. It was obtained and has been preserved in a dry state. By means of a simple piece of apparatus I cause it to be blown about and thoroughly mixed with air. A flame is near it, rapid combustion takes place, and a column of fire of intense heat leaps up in the air, six or seven feet high.

Flour Dust.—This sack contains ordinary flour. Previous to the lecture some of it was placed in a drying oven and submitted to gentle heat. By this time much of the moisture usually contained in flour has been expelled; one condition has been fulfilled to make the substance combustible. I next comply with the other and mix it with air. See the result! Mark the violence attending the combustion.

You may seem astonished, and ask whether this is flour alone. Yes; from the same sack I use some more: this time not with the same result, for it is damp, and the air cannot mix sufficiently to render it even inflammable.

Then we arrive at a very important conclusion. The violence of combustion is the inverse of the moisture of the dust experimented upon.

Other Dust.—We will now put the testimony received so far to the torture of further investigation. I have some lycopodium. You remember its near resemblance to flour dust under the microscope. It is not necessary to dry this as we did the flour, for it is protected by an oily waterproof coat and moisture cannot enter it, but it requires air, for I plunge a lighted taper into its midst, and, as in other instances, neither will the powder burn nor will the taper. I urge some of it through the heated flame with this unexpected result: an all-devouring and explosive column of fire.

Explosion.—The results obtained so far convince us that dust is inflammable in degree according to its dryness. No actual explosion has yet been obtained in our experiments. Perhaps it will be well to define the term explosion, since there has been objection raised to its use in connection with flour combustion by some writers whose opinion is worthy of respect. It almost seems ridiculous to imagine anyone looking at the disaster at Minneapolis could so pervert the English language as to say that no "flour explosion" took place. Our dictionaries give us the definition of the word "to drive or burst out with a loud report or violence." Hitherto we have not then complied with this definition, and therefore had no explosion. Let us see if it is possible to obtain explosion, and by what means. When dry organic dust is heated to the point of ignition, the oxygen and hydrogen first combine to form water. Intense heat is thereby generated, and this heat acts in two ways: first, to char and finally convert the carbon into carbon dioxide gas; and, secondly, to expand the surrounding air. The gas and the heated air occupy considerably more space than in their first state, and the more rapidly these results are achieved the more nearly will the act approach the violence of explosion. The air then plays as important a part as the dust, and should the air space be confined, but insufficient to restrain its force of expansion, explosion in the full sense of the term takes place.

Explosion, Intensity of Combustion.—We can trace the various degrees of combustion in the many mill and factory fires that have been placed on record. Notably amongst them I will call your attention to two—the terrible disaster of Minneapolis, which occurred May 2, 1878, and the Hecker mill fire in New York, July 31, 1882. In the former we may reasonably infer that the air was dry and the dust pretty generally diffused throughout its entire extent, owing to the long-continued and busy period the mill had been taxed with work. The wheat of that year, we are told, was hard and dry, and at the time of the explosion, 7.20 P.M., the air was chilly and the windows and openings generally closed. Here are conditions for explosion. In the latter I will take the testimony of the superintendent, Mr. J. V. Hecker, as recently given before the fire marshal of New York. He says: "The fire originated in the 'smutter' on the seventh floor. 'Smutters' are considered the most dangerous parts of the machinery of a mill, on account of the friction which may be produced by any foreign substance getting in and striking fire between the revolving cylinder and the case surrounding it. These cylinders were of stone and the cases of chilled iron. The smutters make from 250 to 300 revolutions per minute. The dust is sucked from under the smutters and forced by a fan into the (wheat) dust room through a spout about ten inches square. I think the fire was caused by a spark struck by friction in the smutters, igniting the dust and passing through the spout into the dust room and igniting the dust therein." That an explosion did not then occur, as in many other instances, was, I take it, owing to the fact that while the air in the mill was charged with fine dust the dryness was sufficient to cause the flames to spread with lightning-like rapidity through the entire building, making the 500 workmen run for their lives. There was insufficient moisture to allow the dust to burn with the violence characteristic of an explosion. From the meteorological record of that day I find the barometer stood at 30·42, temperature, 82° F., and there was 82 per cent moisture in the air, with cloudy sky. 30 per cent of humidity that day, in all probability, saved the nation from a disaster far more terrible than happened in Minneapolis, or since the history of milling has been recorded.

Many other illustrations might be taken which would find an intermediate place in the degrees of intensity of combustion. You will call to mind the candy-works explosion in the same city some years ago: that was an explosion of starch. The Ehret Brewery in August, 1881, experienced an explosion from the barley used in malting. Barley, in common with wheat and other cereals, consists principally of starch, and no difficulty is experienced in accounting for that phenomenon. The Pullman Car Works, at Detroit, 1880, had an explosion of dust in the spout used for conveying shavings from various portions of the factory to a place near the furnace. This spout is the counterpart of the dust room of the flour mill.

Conditions of Explosion.—We will now proceed with our experiments and see if we can cause those substances which hitherto have shown themselves as highly combustible to become explosive. We will confine the air space and see the result. For that purpose I have before you a simple piece of apparatus which, for a better name, we will call a dust or flour gun. It consists of a hollow shaft about seven feet high. At the top is a hopper, which by means of a paper cover I can close; at the bottom is a gas pipe to which is attached a Bunsen burner. By means of a trigger arranged near the top I can cause a fine shower of dust to descend and fill the shaft. When the first portion of it reaches the flame and the shaft is filled with dust, ignition takes place and the entire column burns. It is necessary that there should be a plentiful supply of air. This is provided for in numerous perfora-

Record of Temperature and Humidity of the Atmosphere at the Flour Mill of Messrs. Jones, Ballard, and Ballard, Louisville, Ky., August, 1882.

Date.		External.		Internal Humidity.			Weather.
Day.	Hour.	Temperature.	Humidity.	Grinding Floor.	Bolting Floor.	Dust Shaft.	
Aug. 10	11 A.M.	70°	52 P.C.	67 P.C.	54 P.C.	.....	Clear
Aug. 11	12 M.	80°	51 ,,	62 ,,	65 ,,	.....	Fair
Aug. 12	3 P.M.	82°	45 ,,	60 ,,	53 ,,	.....	Fair
Aug. 14	3 ,,	89°	53 ,,	54 ,,	53 ,,	43 P.C.	Fair
Aug. 15	1 ,,	81°	87 ,,	83 ,,	83 ,,	60 ,,	Rain
Aug. 16	1 ,,	82°	83 ,,	87 ,,	87 ,,	63 ,,	Rain
Aug. 17	3 ,,	79°	57 ,,	64 ,,	64 ,,	53 ,,	Clear
Aug. 18	3 ,,	83°	48 ,,	52 ,,	52 ,,	38 ,,	Clear
Aug. 19	2 ,,	78°	50 ,,	55 ,,	58 ,,	41 ,,	Fair

tions about the walls of the machine. If the dust is now dry we have all the conditions for explosive combustion. Let us proceed:

I place some lycopodium and turn the trigger. The top is blown off and takes fire, so intense is the heat. Here is some wheat dust from the dust shaft of a flour mill. The result is much the same, only less in degree, and yet sufficiently illustrates the principles we have discussed.

The Wet Bulb Hygrometer.—Before proceeding further in our subject it is necessary that we should understand the construction and use of an instrument that will play an important part in the subsequent line of thought I purpose now leading you. It is known by the modest title of "Wet Bulb Hygrometer," and its mission is easily related.

Its indications tell us that the atmosphere about us on the clearest and brightest day or night contains a large amount of water dissolved in it: that this watery vapour or gas is very transient in its nature, but that very seldom is the air fully charged, and never is moisture entirely absent. When the air has as much water as it can possibly hold we call it saturated, and in that condition we say it has one hundred per cent of humidity. Cold air requires less moisture to saturate it than warm air, hence elevation of temperature means increase of the saturating point.

It tells us that there is a constant variation going on—sometimes at short intervals, and at others in long periods; and it further shows, as we are ready to anticipate, that there is a constant change in the capacity of the air and amount of moisture in it during the twenty-four hours of each day. As I take it, this atmospheric property plays an important part in our investigation of dust combustion.

In various localities the average capacity of the air varies considerably. "In the North American Continent," says Ganot in his admirable text-book on Physics, "where the south-west winds blow over large tracts of land, the relative moisture is less than in Europe; evaporation is here far more rapid: clothes dry quickly, bread soon becomes hard; newly built houses can be at once inhabited; European pianos soon give way here, while American ones are very durable on the other side of the Atlantic. As regards the animal economy the liquids evaporate more rapidly, by which the circulation and the assimilation is accelerated, and the whole character is more nervous. In some parts of East Africa, on the other hand, the air is so charged with humidity that paper becomes soft and sloppy from the loss of its glaze, and gunpowder, if not hermetically sealed, refuses to ignite." As a suggestive thought incidentally to these statements:—Are not the greater number of mill explosions in districts over which a dry atmosphere is known generally to exist? By the indications of this instrument we find regular changes during the day, there being maxima about 8 A.M. and 8 P.M., and minima about 3 A.M. and 3 P.M. The Signal Service record (Louisville) for a few days will suffice to show this fact:—

	6.25 A.M.	10.25 A.M.	2.25 P.M.	6.25 P.M.	10.25 P.M.
Aug. 1 ..	90	79	59	72	88
Aug. 2 ..	82	62	51	61	85
Aug. 3 ..	90	67	57	90	93

Construction.—The instrument in construction is simple, consisting of two delicate thermometers, one of which is kept saturated by a reservoir of water. As the air loses or gains in capacity to dissolve moisture evaporation takes place from the wet instrument. Proportionate to the capacity of the air to contain water will be the degree of evaporation, and the extent of evaporation is indicated by the lowering of temperature. Thus, by a very easily constructed table, showing the difference of temperature readings of the two thermometers, a pretty accurate estimate may be made of the amount of water necessary to produce saturation and the amount already contained therein. The instrument may be easily constructed or purchased for a few dollars at any first-class optician's. It should, however, be accurately adjusted and the scales properly constructed. I will not occupy your time in explaining further how the readings are made, as that information may be obtained from any good text-book on meteorology, but will at once proceed to detail records arrived at by its aid in my subsequent description.

Mill Fires.—The principles I have heretofore laid down, simple as they may appear, I felt convinced underlaid many of the fires and terrible explosions so disastrous to flour mills, and to their ignorance I conceived might be attributed at least some of the most awful catastrophes chronicled in our industries. Every year, to his sorrow, the mill-owner finds his risk of destruction of property and life growing greater, and I believe to-day there are insurance companies that would as soon grant a policy upon a gunpowder magazine or dynamite factory as to the proprietor of a flour mill. I determined to submit these principles to a rigid test. Accordingiy, with hygrometer and note-book in hand, and the valuable co-operation of Mr. Chas. Ballard, a practical miller, I penetrated every crevice and chamber, from basement to roof, of one of the best-ordered mills in the country.*

I will not occupy your time in describing the various parts of an ordinary flour mill, but make use of the technical terms applied to the various localities. Suffice it to say that the mill in question has every modern improvement in milling machinery, is substantially constructed of brick, is run by steam-power, and well ventilated from all sides. The grain is received in the basement; the first floor is devoted to gradual reduction mills, and the second and third floors to bolting machinery and purifiers of the most approved description. It has a capacity of 180 barrels per day.

Mathematics cannot err; mark, now, the extraordinary records:—(See Table).

The first unexpected result we notice in these records is that the atmosphere in both grinding and bolting rooms is moister than the air outside. On closer examination I soon discovered the cause of this. Each set of rollers

* This mill is situated in Louisville, Ky., and owned by Messrs. Jones, Ballard, and Ballard.

used in reducing the grain, 22 in all, was heated, owing to the friction and resistance in crushing. By the heat thus generated the normal moisture of the wheat was continuously being evaporated, and escaped into the mill; the spouts near the rollers were bedewed with moisture and the flour doughed. Notwithstanding that the windows on all sides were open, and the ventilation as thorough as possible, the entire atmosphere of the mill was thus kept in a moist condition.

After carefully examining the purifiers, bolting chambers, wheat cleaners, and other machinery for the dangerous element of dry air, I came lastly to the dust shafts. As I have already stated, in this mill there are two of these—one used for collecting the dust from the wheat cleaning, which is carried to the basement and there collected in a dust-room; the other carries off the light refuse flour dust made in the first reduction of the grain. In making observations I found the amount of moisture in both these shafts, and the various parts of each one, differ so slightly that I did not deem it desirable to note the variation.

The Dust Shaft.—Could science speak plainer to us than in these facts? Recal the many mill fires and explosions that periodically visit us, and does not each narrative begin with the now easily interpreted incident, that destruction commenced at the dust shaft or in its vicinity? Here, month after month, streams of dry air, drier than the hot summer breezes, are urged with the velocity of a storm, depriving the wood and other combustible matter of its moisture, converting all that will burn into tinder-like fuel, dry air separating and buoying up the particles of drier dust until the fatal spark occurs and combustion ensues, with the explosive violence, alas, too well known now to need description.

I do not hold that mills are blown up by the dust alone in the shafts, but I do believe that the fires generally originate there, and the local explosion caused thereby is often sufficient to fill the entire atmosphere of a mill with lodged and loose dust. A second charge is thus prepared for combustion, and the grand explosion occurs.

Dust shafts are then danger centres. Can there be any longer doubt in your minds? Is it necessary for me to suggest that they should be well protected and solidly constructed? Dry air in a mill, I am inclined to think, is little less dangerous than coal-gas escaping in the air. Why make these shafts of light match boarding? Will you longer, in the face of these deductions, use gauze and canvas doors communicating with them and your mills? As I stood one day near by one of these doors my hygrometer showed the dangerous enemy stealing into the dust-charged atmosphere of the mill.

Having accepted the fact, which I take for granted is now settled in your minds, that the dust spouts and flour shafts are drier than the surrounding atmosphere, let us see if science can explain why this should be so. Nearly all dusts are well known to chemists to be hygroscopic in their character. Flour especially will divest moisture from the air. But we have seen also that in the process of grinding, by the heat generated in friction, a large amount of the normal moisture of the grain is driven off, and the subsequent heated flour must necessarily be abnormally deficient in water. The percentage of moisture in the dust shafts would be, of course, governed by the humidity of the external atmosphere, as we find it shown in the table set forth.

The Barometer.—There is another interesting relation between the dust and the atmosphere as its medium, which is at least worthy of a passing remark. Do you know that dust is sometimes lighter than at other times? More correctly, the atmosphere, in its variable density, causes the light particles of floating matter to become more or less buoyant. Let me illustrate the statement by a familiar incident: Have you not noticed at some times, generally on a dry day, how the smoke rising from the chimney will rise and be buoyed up in an almost vertical direction—how on those days the very dust in the roads hangs about and refuses to settle? The barometer on these occasions will be high, showing that the air is dense. Another day the air will be charged with moisture; the smoke hangs about the ground, no dust in the air now, for the air is too light to buoy it up; the barometer is low and rain is probable. Is it only reasonable to infer that during a high barometer the lighter particles of flour are reluctant to settle, and, floating in the air, add to the many dangers of a flour mill? I make this brief allusion to a probable cause conducive to fire and explosion. Time will permit me to do no more.

Deductions.—Gentlemen, the accurate diagnosis of disease points to a line of remedy. Have we not enough information on the cause of dust explosion to suggest a mode of remedy? It may be that we have not yet gone to the bottom of the mysteries involved, but we have, I think, indications enough to adopt a line of treatment.

Let me, as I have presumed so far, in the interest of science suggest:

1. That dust rooms are dangerous centres, and should be built, if possible, of brick, as you would build a smoke stack, and all communicating shafts and doors be of sheet metal.

2. That, as in the long period of drought in summer nature moistens the dry forest with rain and dew, so our parching winds, constantly blown through shoots, shafts, and dust rooms, should be daily, if practicable, charged with vapour or steam.

3. Keep the mill free from superfluous dust and flour.

4. As dry air is the miller's enemy, let him learn to use the hygrometer, and on its indications adopt methods, as he may think best, to drive it from the many lurking places in his mill.

5. In dry weather, when the air is dense and thick with floating particles, let him not overwork or strain the capacity of production. Overtaxing work has often preceded disaster.

6. Never use open lights in the mill if it is possible to avoid them, and get as much ventilation as possible.

Conclusion.—Before concluding the subject I have attempted to lay before you, the course of events makes it necessary to add one more record. After I had formed the line of thought and made observations at Messrs. Ballard and Co.'s mill, an incident occurred that rivetted my interest, as I think it will yours. After hunting nature to the utmost limits of investigation, I was rewarded beyond measure in an occurrence which took place unexpectedly to all, but unfortunately for my friends in labour, the Messrs Ballard.

When lecturing before the Millers' Association of Kentucky, I made the following remarks: "Could we have had a register of the state of the atmosphere in the unfortunate Washburn mill, Minneapolis, immediately preceding the explosion, I doubt not that it would have shown a marked absence of humidity." Science has permitted me to realise this, for on August 22, my closing record at the mill reads:

Date.	Hour.	External. Temperature.	External. Humidity.	Interior.	Weather.
Aug. 22	11 a.m.	82°	60	Wheat dust shaft and adjoining bin on bolting floor now in flames. Fire confined to upper portion of shaft, but fierce and destructive.	Fair

What originated the fire I pass uncommented upon. The fact that the dust shaft burned with rapidity, and that the entire mill was but a wreck from either the flames or explosion, I leave for your thoughtful consideration. On the spot where I had made my observation, in the wheat dust room, the last time I visited the building,

there remained only the ruins of property estimated from eight to ten thousand dollars.—*Journal of the Franklin Institute.*

NOTICES OF BOOKS.

Weights and Measures. Report by the Board of Trade on their Proceedings and Business under the Weights and Measures Act, 1881. 1882.

Weights and measures, though little noticed by the public at large, form a subject of great importance. They appear to require a very close supervision, and it appears doubtful whether the law confers in all cases sufficient power. Thus we read:—"Inspectors have lately complained that they find much fraud in the weight of made-up parcels, and that they have no power under the Act to enter shops and examine the weight of made-up quantities of goods offered for sale. The custom of trade sometimes, however, appears to sanction the sale of parcels of goods on which the specified weight, or measure, or number differs from the actual weight of the goods." Surely the law should not for a moment tolerate customary frauds to which the purchaser submits either from ignorance or because he is in the shopkeeper's debt. We may here note the existence of specially weighted papers used for wrapping up parcels of goods and weighed along with them.

Incorrect weights in the use of pharmacists are a source of danger to the public, overweight being here even worse than a deficiency. It is therefore not reassuring to learn that the St. Pancras inspector "lately visited 36 chemists' shops, and in nearly every case reported the weights, &c., unjust or incorrect." In Edinburgh a pharmaceutical chemist was fined for having unstamped and erroneous weights used in dispensing poisons. Of three 6-grain weights one was found one-tenth gr. too heavy, and the two others three-tenths gr. deficient, thus giving a range of error of four-tenths grain according as one or the other of these weights happened to be used. A one-grain weight was half-a-grain too heavy, and of three five-grain weights one was found to be three-tenths grain too heavy, and another nine-tenths grain deficient! Such variations are surely enough to gravely modify the nature of a prescription in case of physiologically active substances.

Nothing seems to have been done as regards the adoption of the metric system beyond the verification of metric standards for scientific purposes, and the official issue of new cards of equivalents of imperial and metric weights and measures.

In connection with the baking trade we have an instance of the "glorious uncertainty of the law." The Middlesex magistrates decided that an inspector could not enter a bakehouse to examine the weights, whilst about the same time the Hants magistrates convicted a baker for obstructing the inspector by denying him access to the bakehouse.

We find mention of hoped-for legislation for regulating the measures used in the sale of gas and for testing its illuminating power. This is an admission that in existing arrangements there is room for improvement.

As regards the testing of petroleum, Dr. Foerster, Director of the Imperial Standards Commission of Germany, has detected an important oversight. No allowance has hitherto been made for the variations of atmospheric pressure at the time of taking the flashing-point. It appears that a fall of the barometer, very naturally, lowers the flashing-point. Some oils recently tested in London, when the barometer marked 29·80 inches gave flashing-points of 89° and 74° F. respectively. When tested at Buxton with the barometer at 28·35 inches they flashed at 86° and 72° F.

It is also mentioned that samples of oil tested at Calcutta gave a lower flashing-point than they had done at London and New York. This may possibly be due neither to the apparatus nor to the mode of using it, but simply to the circumstance that prolonged exposure to a high temperature previous to testing reduces the flashing-point of the oil.

Patent Safety Lamps, and Prevention of Explosions in Collieries. By W. Crossley, M.I.C.E., F.C.S. Glasgow: P. Bertram.

The author has adopted in his safety-lamp an entirely novel principle. He proposes to fix throughout coal-mines iron-piping similar to gas-piping, but conveying atmospheric air obtained from the outside of the mine. This air supports the combustion of the safety-lamp, which is thus not brought into contact with the atmosphere of the mine at all. There are at the top two specially contrived apertures for the escape of the products of combustion, which, before passing out, are cooled down so as to be incapable of igniting an explosive mixture. To prevent the air of the mine from forcing its way into the lamp the supply of air from outside the mine is forced into the lamp under pressure. Any attempt to disconnect the lamp so as to get at the flame extinguishes it at once. Another point, of apparently great importance, is its superior luminosity, so that the temptation to open the lamp in order to get a better light must disappear. The new lamp, indeed, is said to give nearly as much light as a photometric standard, and is consequently equal in efficiency to 8·00 Davy lamps (with gauze), 18·50 Stephenson's lamps, and 24·50 of the Upton and Roberts's pattern. Whether mine-managers will think it convenient to lay down a system of air-pipes in order to light up their workings on this system we cannot venture to guess. But we fear that the majority of explosions are due to the recklessness of the men who carry matches and tobacco-pipes down with them. After fatal explosions such articles are not unfrequently found concealed about the bodies of the dead.

Pollution of the Passaic River, embracing the Report of the Special Committee appointed to represent the Newark Aqueduct Board in the Board of Inspection of the Passaic River and its Tributaries. Newark, N.J.: Inglis and Co.

The pollution of rivers is coming most unpleasantly to the front in the United States. This clever nineteenth century of ours has not yet found out how to carry on manufactures without filling air, water, and earth with nuisances, and if a community will make haste to grow rich it must accept the drawbacks which are so far closely linked with industrial progress. The Passaic River supplies, it appears, the important cities of Newark and Jersey with water for domestic consumption. Formerly the supply seems to have been satisfactory. But according to the analyses of Professor A. R. Leeds it contains 0·03 part of albumenoid ammonia, 0·444 of nitrates, and 0·39 of chlorine. Dr. Leeds, on examining samples taken at a series of points along the stream, notices the impurities introduced by refuse at Paterson. A very important point is "the extent to which the impurities introduced are oxidised and destroyed in the further course of the river. These oxidising effects are especially noticeable during the flow of seven miles." Thus just above Paterson the proportion of albumenoid ammonia was found to be 0·016 grain per gallon. Below Paterson it had risen to 0·068, whilst at Broadway Bridge it had sunk to 0·024, and at Dundee Dam to 0·018. These samples were taken in rapid succession on the same day.

These results confirm those obtained in the river Vesle, above and below Rheims, and prove that the conclusion formed by the late Royal Rivers' Pollution Commission, if true of certain excessively contaminated English streams, does not hold good universally. Professor Leeds seems

to be of opinion that with due care the waters of the Passaic may be restored to purity. It appears that among other nuisances complained of, the citizens of Newark were afflicted with the smell and taste of carbolic acid, which was found—as we can well imagine—especially unpleasant in tea. Judge McCarter, who tried the case, ruled that it was not necessary for the carbolic acid to be in poisonous quantity in order to constitute a punishable nuisance. "It is sufficient if it render the water offensive or disagreeable to the taste or smell.

Agenda du Chimiste. (The Chemist's Memorandum Book). Paris: Hachette et Cie. 1883.

The object of this little book is to supply the chemist and technologist, within a small compass and in a convenient and methodical manner, with all the more frequently occurring numerical data required in every-day practice either in the laboratory or the workshop. The arrangement of the contents is somewhat similar to that of the English and German works of the same kind which we have already had occasion to notice, and much care has evidently been taken in bringing together such a heterogeneous mass of facts so as to render them reliable and convenient for use.

In Chapter I., which relates to physics and mathematics, are given many useful tables, such as for barometric and thermometric corrections, densities of solids, liquids, and gases, reductions employed in gas analyses for facilitating the calculations, melting- and boiling-points of some inorganic bodies, indices of refraction, &c.

Chapter II. is devoted to pure chemistry and contains data of frequent use in analyses by the wet and dry methods, factors for the calculation of analytical results, spectral and gas analyses. The most important section of this chapter contains the physical constants of a great many organic and inorganic bodies, their melting- and boiling-points, densities, and formulæ. The mineralogical table contains the characteristics of several hundred species arranged alphabetically, with their formulæ, hardness, crystalline form, and some of the important faces indicated with the hieroglyphic notation that finds favour with the French school of mineralogists.

Chapter III. contains many tables that will be of service to the technologist, as the composition of various alloys, glass, ceramic wares, and explosives, methods for the analysis of soaps, oils, butter, sugar, alcoholic liquids, manures, &c.

To the supplement to this edition of the "Agenda," M. Boussingault contributes a small notice on chocolate and cocoa, giving a description and the composition of specimens of these articles from different localities, and a few statistics of commercial value. Thermometric measurements and the determination of melting- and boiling-points is discussed by M. J. M. Crafts. M. G. Salet gives a short and concise notice of the transmission of force by electricity, and M. A. Henninger contributes an article on ferments and fermentation, in which an account of much of Pasteur's work is given, relating to conditions that affect the life of ferments.

This little work has now been before the chemical world for several years, and we have no doubt that although the English chemist has a book of reference of a similar kind in his own language its quality will still entitle it to a place amongst us.

Perfumes and Essences: a New Process of Industrial Extraction by Means of a Vacuum and a Low Temperature.—Laurent Naudin.—The author, after pointing out the defects of distillation, *enfleurage*, &c., proposes to extract perfumes by contact with a solvent, circulating in a somewhat complicated machine, which is here figured. Among the solvents used are alcohol, ethyl, and methyl chlorides, butyl and amyl hydrides, oils, glycerin, carbon disulphide.—*Moniteur Scientifique.*

CORRESPONDENCE.

ACID-RESISTING BRICKS.

To the Editor of the Chemical News.

Sir,—Our attention has lately been called to a report of a meeting of the Newcastle Chemical Society (Chem. News, vol. xlvii., p. 55), upon which occasion a paper was read by Mr. Morrison on "Acid-Resisting Bricks." The Welsh blue fire-bricks certainly obtain a very favourable opinion from him, but his remarks gave the impression that the use of these bricks in Glover's towers is a recent thing—a new discovery. To correct this idea we beg to refer your readers to Lünge's celebrated work on the subject, in which he specially recommends the Welsh blue bricks, under the name of "the blue bricks of Mold," for this particular purpose. We may also mention as an instance of their long-tried excellency that bricks supplied by ourselves to Messrs. Muspratt, of Flint, have been in use in a Glover's tower for thirteen years.—We are, &c.,

Edward Parry and Sons.

Buckley, Mold, March 20, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 4, February 20, 1883.

Transformation of Carbon Oxysulphide into Ordinary Urea and Sulphurea.—M. Berthollet.—The author has already shown how carbon oxysulphide and ammoniacal gas form, by their combination, ammonium oxysulphocarbamate, which in turn is converted into urea by the simple elimination of hydrogen sulphide. This transformation is particularly sharp in presence of metallic oxides. On the other hand, by simply evaporating the aqueous solution in heat, there is produced a crystalline matter formed of urea, mixed with a smaller proportion of sulphurea and a little ammonium sulphocyanide.

Electrolysis of Oxygenated Water.—M. Berthelot.—Previously noticed.

Decomposition of Cyanogen.—M. Berthelot.—Already noticed.

Atomic Weight of Lanthanum.—P. T. Clève.—In 1874, the author made some determinations of the atomic weight of lanthanum by the synthesis of the sulphate. He found then that the anhydrous sulphate contained 57·619 per cent of La_2O_3, whilst M. Marignac had shortly before obtained the closely approximating number 57·547, and M. Brauner subsequently found 57·549. All these values give in round numbers 139 as the atomic weight of lanthanum. More recent investigations have led M. Brauner to the atomic weight 138·28. These researches seem to denote the existence of a foreign oxide accompanying lanthanum. The author himself was at one time induced to admit the existence of such a body by the observation of a blue ray ($\lambda = 4333{\cdot}5$) in the spectrum of the fractions intermediate between lanthanum and didymium, but a further examination proved that this ray belongs to lanthanum. To decide the question of the existence of this hypothetical body intermediate between lanthanum and didymium, the author has submitted mixtures of lanthanum and didymium to several series of partial precipitations by dilute ammonia. His results give for lanthanum the atomic weight 138·019 ($O = 15{\cdot}9633 \pm 0{\cdot}0035$). They show that lanthanum is not split up, and that its oxide

is a homogeneous body. The discrepancy with the author's former results may arise from the extreme difficulty of eliminating from the sulphate every trace of free sulphuric acid without setting up incipient decomposition. The only fraction which could contain a foreign earth is probably merely a mixture of didymium and lanthanum.

Journal de Pharmacie et de Chimie.
Tome vii., March, 1883.

Composition and Singular Properties of a Serous Pathological Liquid.—MM. J. Regnauld and Villejean.—This paper is rather of medical than of chemical interest.

Organic Synthesis and Thermo-chemistry.—M. Berthelot.—The author maintains that there is in the physical relations of carbon and of its compounds something peculiar which the other elements do not present. On examining the facts more closely he is led to think that the true element, carbon, is unknown, and that diamond, graphite, and the other varieties of carbon are substances of a different order. Elementary carbon ought to be gaseous at the ordinary temperature; the various kinds of carbon which occur in nature are in reality polymerised products of the true element, carbon. Spectral analysis seems to confirm this view; if into a Geissler tube we put any carbonised vapour or gas, carbon monoxide, cyanogen, carbon disulphide, &c., the spectroscope shows two associated spectra. The one presents the rays of the body associated with carbon, whilst the other is the same whatever may be the compound of carbon examined. Hence it may be thought that this second spectrum belongs to gaseous carbon. This spectrum has been lately recognised along with that of hydrogen in the light of the tail of comets, which indicates a carbide, probably acetylene.

Action of Carbonic Acid upon a Solution of Neutral Lead Acetate.—Felix Bellamy.—In neutral solutions a current of carbonic acid produces a turbidity of lead carbonate, whilst the liquid becomes distinctly acid. In a quantitative experiment 77 per cent of the lead acetate was decomposed, yielding an equivalent quantity of lead carbonate.

Direct Determination of Sulphurous Acid and Hyponitric Acid in a Gaseous Mixture.—M. Quillart.—The author takes three tubes of glass, each 12 c.c. in length, of the width of test-tubes, connected together by smaller tubes and caoutchouc stoppers. The tubes are filled with asbestos saturated with a known weight of lead peroxide. The tubes, after being thus prepared and dried, are weighed exactly, and the dried mixture of sulphurous and hyponitric gases is passed slowly into the tubes by means of an aspirator, which at the same time measures the volume. The gases are totally absorbed, and the tubes are then weighed a second time. The increase of weight shows the exact weight of the known volume of the gases. To ascertain the weight of each separately, the plumbic asbestos is thrown into hot distilled water, a little pure barium carbonate is added, and the mixture is boiled. The barium carbonate completely decomposes the neutral and basic lead acetates, forming barium acetate, which is extracted by washing. The barium in the filtrate is determined as sulphate or carbonate in the ordinary manner, and from its weight the proportion of hyponitric acid is calculated. The weight of the latter, deducted from the increase of the weight of the tubes, gives the weight of the sulphurous acid.

Arsenic Acid recognised by the Silver Reaction.—E. Salkowski.—The author dissolves arsenic sulphide in fuming nitric acid, expels the greater part of the acid by evaporation, heats the residue with water, holding in suspension calcium or barium carbonate, and filters. Calcium and barium arseniates are sufficiently soluble for the filtrate to give a red precipitate on adding silver nitrate.

Moniteur Scientifique, Quesneville.
February, 1883.

Industrial Society of Mulhouse.—Session of December 13, 1882.—M. A. Scheurer read a report on the researches of M. Grosseteste on the weakening of cotton fibre under the influence of heat. M. Eugene Dollfus called attention to the action of chlorides present in size if submitted to a temperature of more than 100°. M. Albert Scheurer pointed out that a mixture of certain chlorides is dissociated more readily than any of them taken singly.

M. Noelting, in his own name and in that of M. A. Collin, communicated the results of certain experiments undertaken on the nitration of aromatic amines under different conditions. M. Noelting, along with M. Kobu, has also studied the products resulting from the action of diazo-derivatives upon paracresylol. He also announced that, in concert with M. Wild, he had prepared certain derivatives of aniline containing the radical isopropyl.

Patents taken Abroad.—The specifications of a number of chemical patents, relating chiefly to colouring-matters.

Metals of Cerite.—Dr. Bohuslav-Brauner.—This paper has appeared simultaneously in the *Journal of the Chemical Society*.

Considerations on the Doctrine of the Three Fundamental Fibres of Young as the Basis of a Theory of the Sensations of Colour.—M. Giraud-Teulon.—A purely physiological paper. The author considers Young's theory as being directly at issue with facts.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Nitrogen in Leather.—In the Chemical News, vol. xlvii., p. 131, I observe a paragraph as to "Decomposability of Nitrogenous Animal Matters." I am very anxious to know the author's conclusions as to the ground leather—a subject which has been much discussed in Scotland, especially compared with dried blood.—W. B.—[Of 100 parts of nitrogen in ground leather, 39·19 parts were rendered soluble by treatment with pepsine (which the authors think will in its solvent powers approach the action of ferments present in the soil, &c.). Of 100 parts ditto in dried blood, 89·75 parts were rendered soluble by the same process. The dried blood used in the authors' experiments contained 13·54 per cent total nitrogen, and the ground leather 6·91 per cent.—*Ed.* C.N.]

MEETINGS FOR THE WEEK.

Monday, April 2.—Medical, 8.30.
—— Society of Chemical Industry, 8. "The Stassfurt Salts and their Mode of Treatment," by Mr. C. Napier Hake.
—— Royal Institution, 5. General Monthly Meeting.
Tuesday, 3rd.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
Wednesday, 4th.—Society of Arts, 8.
—— Pharmaceutical, 8.
Thursday, 5th.—Chemical, 8. "Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal-Gas," by Mr. Lewis Wright.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Royal Institution, 3. "Art of Pheidias," by Dr. Waldstein.
Friday, 6th.—Royal Institution, 8. "The Canons of the Far West," by Mr. A. Geikie, at 9.
Geologists' Association, 8.
Saturday, 7th.—Royal Institution, 3, "Geographical Evolution," by Mr. A. Geikie.

Errata.—Page 125, col. 2, line 18 from top, *for* 0·500 *read* 0·550; p. 126, col. 1, line 42 from top, *for* 07·25 *read* 0·725; p. 127, col. 1, line 8 from top, *for* 0·290 *read* 0·280; p. 136, col. 2, line 3 from bottom, *for* 0·92 *read* 0·02.

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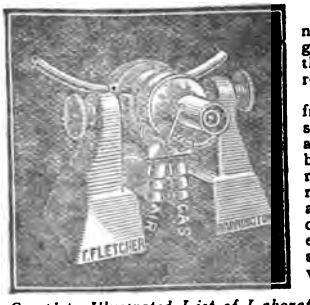

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1219.

PRELIMINARY NOTE ON THE INFLUENCE OF ABSORBED GASES UPON THE ELECTRICAL CONDUCTIVITY OF CARBON.

By I. PROBERT and ALFRED W. SOWARD.

It has long been known that carbon in the form of charcoal has the power of condensing gas within its pores. (Lametherie, *Journ. de Phys.*, xxx., 309; Morozzo, *Ibid.*, 1783, 376; *Nicholson's Journ.*, ix., 255, and x., 12: Rouppe and Van Noorden, *Ann. de Chim.*, xxxii., 3.) The exact experiments of De Saussure (*Ann. Phil.*, vi., 241 and 331) and of Hunter (*Phil. Mag.*, [4], xxv., 364, xxix., 116) show that the more readily the gas is reducible to the liquid state the greater is the quantity absorbed, and the experiments of Melsen (*Comptes Rendus*, lxxvi., 81, 92) prove that in some cases the absorbed gas is actually liquefied.

It is known that in the case of a pile of carbon powder the apparent resistance to the passage of an electric current is not a true resistance, but may be resolved into two factors the real resistance of the carbon particles, and a disturbing influence traceable to the presence of gas filled spaces. In the case of a block of carbon, where cohesion exerts its power upon the particles, the spaces are smaller, and the disturbing influence due to them must consequently be less: but the spaces exist, as is evidenced by the experiments of Lametherie and others referred to above, and it is reasonable to suppose that the presence in these spaces of greatly condensed, and sometimes liquefied, gas must sensibly affect the electrical conductivity of the carbon. So far as we know, no experimental verification of this conclusion has been announced.

During the past year we have been conducting a series of experiments, in the course of which we have incidentally had the opportunity of measuring the electrical conductivity of specimens of a very porous variety of carbon in different gases at different pressures, and we have found that the conductivity is not a constant for a given temperature, but varies with the chemical nature and density of the absorbed gas.

Further (quantitative) experiments are in progress, the results of which we hope shortly to announce.

ON A NEW TEST FOR TITANIUM, AND THE FORMATION OF A NEW OXIDE OF THE METAL.

By EDWARD JACKSON.

If peroxide of hydrogen be added to an acid (HCl or H_2SO_4) solution of titanium a fine yellow or orange colour is developed, according to the strength of the titanium solution. This test is exceedingly delicate: a quantity so small as the 1-50,000th of a grm. in 1 grm. of the solvent can be easily detected. The test is valuable because it has hitherto been difficult to detect minute quantities of the metal, especially when mixed with iron, alumina, or silica.

Conversely, a solution of titanic oxide can be used as a test for peroxide of hydrogen, and is one of the most delicate and characteristic tests known for that substance. A quantity so small as 1-56000th of a grm. of a ten volume solution in 1 grm. of water can be easily detected by adding an excess of titanic oxide. A ten volume solution contains only about 2 per cent H_2O_2, therefore 1:250,000th of a gramme of H_2O_2 can be detected.

As far as the writer knows there is only one other substance which gives a reaction with peroxide of hydrogen similar to titanic oxide, this other substance being molybdate of ammonia in nitric acid. Even here there is a difference in the colour, the latter being of a greenish yellow and the former of an orange yellow. The test with titanic oxide is much more delicate than with ammonic molybdate, and the spectroscope distinguishes between the two coloured solutions easily, the former showing no blue or green in strong solutions, only orange and red remaining, with ammonic molybdate the whole of the green and some of the blue is visible.

In applying the test certain precautions are necessary:—For instance, no colour will appear on adding peroxide of hydrogen to titanic oxide if a large quantity of hydrofluoric acid be present, though the colour may be developed on adding a larger excess of hydrochloric acid. Ferric chloride should also be absent, as the yellow colour may mask the colour of the titanium solution.

Believing that a new oxide was formed, the following investigations were undertaken:—

The highly coloured solution can be filtered without losing its colour.

Ferrocyanide of potassium and tincture of nut-galls only gave a precipitate on long standing.

Reducing agents, such as Zn or SO_2FeO'', destroy the colour.

On neutralising the coloured solution with caustic or carbonated alkalies, or with ammonia or carbonate of magnesia, a pale lemon-coloured precipitate is thrown down. The precipitate may be washed with cold water, and on re-dissolving in dilute hydrochloric acid the colour will be restored in all its original intensity.

Heat destroys the colour, oxygen being evolved.

On adding a solution of potassic permanganate to the highly coloured solution both are decomposed, the resulting solution being colourless if mixed in the proper proportion. The chemical change probably takes place according to the equation—

$$5(TiO_2)_xO + Mn_2O_6K_{O_2} = 2MnO + K_2O + 5(TiO)_x + O_{10},$$

the oxides of course being taken up by the free acid present.

The solution of the new oxide may be mixed with a solution of chromate of potassium without decomposition of either taking place. This is interesting, because it shows that the additional atom of oxygen is differently combined in the titanic oxide to what it is in peroxide of hydrogen: if an excess of peroxide be present all three substances are apparently reduced.

An attempt was next made to ascertain the composition, but this met with only partial success, indeed the composition seems to vary much, though this variation may be due to the washing the precipitate undergoes to free it from peroxide of hydrogen. The method adopted was to oxidise ferrous sulphate, ascertaining the end of the reaction by using ferricyanide of potassium as an indicator, and from the quantity of iron oxidised to calculate the composition. Very discordant results were obtained.

Another method was to ascertain the quantity of potassic permanganate a given quantity of the oxide of titanium would decompose, but no better success was met with, though it was ascertained that the quantity of iron oxidised and the quantity of permanganate decomposed were equivalent.

By using peroxide of hydrogen as a test, titanium has been found in places, the writer thinks, hitherto unsuspected. It is found in comparatively large quantities in the ash of coal. The writer has examined very many samples of coal, some of them from widely separated districts, and in every instance has succeeded in detecting titanium. In many cases the result was confirmed by concentrating and reducing with zinc, when the well-known and characteristic purple colour was developed.

In one estimation the quantity of titanic oxide so found was equal to about 0·1 per cent of the ash. The method of testing for titanium in the ash of coal is very simple. The ash, which should be well burnt, is heated with concentrated sulphuric acid to which a few drops of nitric acid has been added. The acid is next allowed to cool, and a large quantity of water added, filtered, and then tested with peroxide of hydrogen.

As coal is a vegetable product, it occurred to the writer that titanium might occur in the ash of plants. Accordingly some pine saw-dust was burnt, and the ash tested, when titanium was found. It has since been found in the seed of French bean, and in the ash from cotton seed cake. No further investigations have been made in this direction if we except two samples of soil which were examined, and in both of which titanium was found. It is just possible that the metal occurs in the bodies of animals, but this has not yet been put to the test.

In conclusion the writer would suggest that this colorimetric test may be made a quantitative one where only minute quantities of titanium have to be estimated, especially in certain qualities of steel to which titanium is added, but the whole subject wants working out, as only one or two experiments have been made in this direction.

ON INSENSIBILITY ARISING FROM A DEFICIENCY OF OXYGEN IN THE AIR.*

By WILLIAM WALLACE, Ph.D., F.R.S.E., F.I.C., F.C.S.

THE evil effects of breathing the air of crowded apartments were formerly ascribed to the existence in such air of an abnormal quantity of carbon dioxide, usually called carbonic acid gas, which was stated to be a deadly poison; but the views of chemists and physiologists in regard to this have been much modified of late years, and some authorities have gone so far as to express the opinion that it is not a poison at all, in the ordinary sense of the word. A little consideration will show that the effects resulting from breathing the air of a confined and over-crowded apartment cannot be due exclusively, or even chiefly, to the presence of carbonic acid gas; for that gas, as well as the aqueous vapour of the breath, is formed at the expense of the oxygen of the air, which diminishes in constant ratio to the increase of the products of the combustion of our food. For every per cent of carbonic acid gas produced, there is a little more than 1 per cent of oxygen taken up. Allowing, then, that carbonic acid is to some extent detrimental to the system when breathed, the effects to which I have referred are, at least partly, due to the diminished proportion of oxygen; and there is the further complication of an atmosphere saturated with aqueous vapour, and contaminated with the undefined volatile organic emanations from skin and lungs, which give a peculiar and oppressive feeling of "closeness" to the over-crowded and unventilated room. I think, however, that physiologists are now agreed that the lethargy, amounting in extreme cases to coma, produced by breathing such air, results from deficient oxygenation of the blood; and it is a fair inference that the most important factor in the phenomenon is the lessened proportion of oxygen. The normal proportion of that gas is from 20·9 to 21 per cent of the air when freed from aqueous vapour; and Dr. Angus Smith has shown conclusively that this proportion cannot be altered, even to the extent of $\frac{1}{2}$ per cent, without producing appreciable effects, while a loss of $\frac{1}{2}$ per cent gives rise to serious inconvenience, and air containing only 20 per cent of oxygen may produce grave consequences if breathed for a considerable time. On the other hand, a man can breathe, for a short time, an atmosphere containing only 16 per cent of oxygen and about 4 per cent of carbonic acid gas. When the deficiency of oxygen exceeds this to a sensible extent a candle refuses to burn, and a man exposed to it is speedily overcome and becomes insensible.

In all ordinary instances of this kind there are the complications I have spoken of, and I have thought the Society would be interested in a case which came under my notice about six months since, in which there are no such complications.

In the construction of a railway-bridge over the Forth, near Alloa, a number of iron cylinders were sunk in sections or rings of 6 feet diameter and several feet in height, and making up in all, when finished, about 60 feet. I will not go into the mechanical details of the construction of the cylinders, except in so far as to say that the sections were placed one on the top of the other in such a way that a rather wide space was left all round, which had to be filled up from the inside with a rusting composition, well known to engineers, composed of iron turnings mixed with a small quantity of flowers of sulphur, with the addition, in some cases, of a little powdered sal-ammoniac. This mixture, when wetted with water, soon oxidises, and swells up so as to completely fill up the spaces into which it is thrust. At the Alloa bridge a considerable number of the cylinders had been erected, the most of the "rusting" having been done by one man, who mixed up the composition with water in a pail and applied it to the joints without being affected by it to any appreciable extent. On one day, however,—I think about the beginning of May,—when there was a perfectly still, somewhat hazy atmosphere, and considerable heat without direct sunshine, this man was observed to become overpowered by some mysterious influence, and a companion descended by a windlass on the top to bring him up. He managed to get him propped up in the bucket, in which he was pulled up to the fresh air, when he soon revived; but his deliverer was in turn overpowered, and, falling back into a pool of water at the bottom of the cylinder, was drowned. One of the contractors now descended, taking care to fasten a rope to his body in case he too might be rendered insensible by the noxious gas, which was now supposed to be present at the bottom of the cylinder; and fortunately so, for he speedily succumbed and was immediately pulled up by the rope.

On being consulted regarding this apparently mysterious occurrence, I at once saw that the theory of an accumulation of carbonic acid or other noxious gas at the bottom of the cylinder was untenable, for the bottom was covered with water, and no gas could have come up from the bed of the river without being seen bubbling through the water. A few experiments with the rusting composition, a quantity of which was supplied to me, clearly showed that it absorbed oxygen from the air with great rapidity, so that in one of my experiments a portion of air was deprived of its oxygen in ten minutes to such an extent that it would no longer support the combustion of a candle, and in two hours 16 per cent was absorbed. In another case, continued for a longer period, a loss of 20½ per cent occurred, or nearly the whole of the oxygen. At the same time the mixture became very warm, the temperature in one case rising to 156° F., while the iron oxidised and the mixture acquired a brown colour. I had no hesitation, therefore, in ascribing the accident to the absorption of the oxygen of the air in the cylinder by the rusting composition, coupled with the peculiar condition of the atmosphere, which, while it favoured chemical action between the oxygen and the iron and sulphur in the mixture, prevented the circulation of the air in the cylinder, which usually took place to a sufficient extent to prevent serious consequences. The deadly gas at the bottom of the cylinder was therefore nothing more nor less than the nitrogen which constitutes four-fifths of the bulk of our atmosphere, but which, deprived of its companion oxygen, is entirely unable to support respiration. We have in this unfortunate occurrence, by which one life was lost and others endangered, a justification of the German name of nitrogen,

* Read before the Philosophical Society of Glasgow.

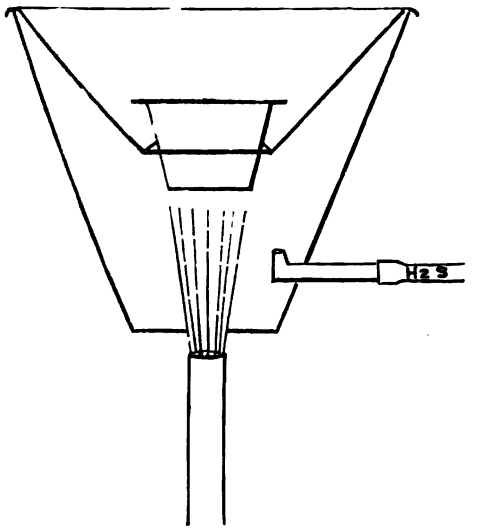
stickstoff,—which may be freely translated choke-stuff or choke-damp,—a name which in our language is applied exclusively to carbonic acid gas.

DETERMINATION OF ZINC AS ZnS.

By R. MACARTHUR.

THE solution, which should be as neutral as possible, is rendered alkaline with ammonia, add acetic acid till acid reaction, pass sulphuretted hydrogen through till the zinc is completely precipitated; allow to settle, carefully decant the clear liquid, then fill the beaker up with strong sulphuretted hydrogen water to which has been added a solution of ammonic acetate, repeat twice, then transfer to filter, and dry. The ignition is performed as follows:—

A No. 6 Hessian crucible has a hole drilled through the bottom large enough to admit the flame from a Bunsen burner. About ¼ in. above the bottom a smaller hole is



drilled to admit a glass tube, which is bent upwards inside the crucible. The crucible in which the ignition is conducted is suspended in a triangle, about the centre of the Hessian crucible. When ready for ignition an energetic current of H_2S is passed through a drying tube, then through the glass tube into the crucible. The filter is ignited on the crucible lid, the flame of the lamp playing up through the large hole. Lastly, the crucible containing the ZnS is introduced, the lid put on, and ignited at a red-heat for ten minutes. Care must be taken to keep a steady stream of H_2S running.

By this method I have obtained the following per cent of same material:—No. 1. 92·180 per cent Zn; No. 2. 91·951 per cent Zn.

Philadelphia, March 18, 1883.

Improved Cock for Chemical Apparatus.—E. Hart.—This consists of two glass tubes, the one within the other, and connected by a piece of caoutchouc tubing drawn over both. The end of the narrower tube which projects into the wider one is closed at the lamp. At some distance from this end a lateral aperture is made with a file. If the narrower tube is drawn so far out of the wide one that the opening is closed by the caoutchouc tube, both are shut off from each other.—*Zeitschrift für Analytische Chemie.*

THE CHEMISTRY OF THE BESSEMER CONVERTER.*

ON Saturday evening, March 10th, Mr. J. E. Stead, F.I.C., F.C.S., the eminent metallurgical chemist, of the well-known firm of Pattinson and Stead, delivered an interesting Lecture before the Cleveland Iron Trade Foremen's Association, in their usual meeting-place in Corporation Road, Middlesbrough.

The Lecturer began by saying that the Bessemer converter was by far the most important metallurgical instrument of modern times. It had become even more important during the last few years, since the discovery and practical development of the Basic process, commonly called the Thomas-Gilchrist process, from the names of the inventors. By means of that system, as was well known, immense quantities of phosphoric pig-iron, which had before been deemed to be unsuitable for making steel, had been rendered, in a commercial as well as a chemical sense, available for the Bessemer process. This fact—for, notwithstanding the contrary opinions of some authorities, it was a fact—was of special importance to such districts as that of Cleveland, where there was made annually an enormous quantity of phosphoric pig-iron, which might by means of the new system be converted into excellent steel. He was going to speak to them that night of the chemistry of the Bessemer converter, and he would try to show them how the process was conducted, with what kind of material and what kind of steel was the result. He would also compare the ordinary or acid Bessemer process with the new basic system, pointing out their several differences both as regards method and materials used.

Before entering upon the chemical details the Lecturer exhibited upon a screen, by means of the oxy-hydrogen lantern, a series of views showing various kinds of Bessemer plants.

The material for lining the ordinary vessel was ganister, the composition of which he exhibited on the screen as follows:—

	Sheffield Ganister.		Good Mixture.
	No. 1.	No. 2.	No. 3.
Silica	85·0 p. ct.	92·0 p. ct.	91·2 p. ct.
Alumina	4·0 ,,	8·0 ,,	6·0 ,,
Peroxide of iron ..	1·5 ,,	2·5 ,,	1·7 ,,
Lime	0·1 ,,	0·3 ,,	0·25 ,,
Oxide of magnesia .	0·3 ,,	0·5 ,,	0·25 ,,
Oxide of potassium	0·2 ,,	0·6 ,,	0·38 ,,
Oxide of sodium ..	0·3 ,,	0·4 ,,	0·32 ,,

What was wanted was a substance which would resist the action of very high heats, and be of such a plastic nature when damp as to hold together when placed in the converter. Thus it was very necessary to have about 6 per cent of alumina in the mixture, or otherwise it would be too sandy, and would be a useless mixture. It is very important that in choosing a ganister only such stones as are very free from the alkalies, potash, and soda should be selected, because these bodies—when present only in moderately large quantity—so affect the refractory properties of the bricks as to make them readily fusible at a high temperature.

The next slide gave the analysis of the material used for lining the vessels working on the basic system, as follows:—

Basic Linings.

Lime	49·91 per cent.
Magnesia	30·72 ,,
Alumina	4·50 ,,
Oxide of iron	3·46 ,,
Silica	11·41 ,,
	100·00

* Revised and supplemented by the Author.

The noticeable feature of this was that, whereas in the ganister or acid lining the predominating constituent was silica, in the basic lining there was only 11 per cent of silica, the great bulk of the material being lime and magnesia. Different experimenters had experienced difficulty in using ordinary lime or limestone as refractory lining; but Messrs. Thomas and Gilchrist had succeeded at last in making a basic lining that would stand well. There were two or three ways of making good basic linings. The chief one was as follows:—Finely-ground magnesian limestone was moulded into bricks, which were then calcined in a kiln until all the carbonic acid was expelled and the substance had shrunk down to about half its original bulk: but they were in this stage ugly shapeless things, quite unfit for building up a lining, so they were taken to a mill and ground up to a rough powder. This powder was mixed with from 9 to 10 per cent of boiled coal-tar,—that is, tar from which the water has been all removed. If any quantity of water remained the lining would be liable to burst, owing to the slaking and consequent expansion of the lime in the composition. This mixture of tar and basic material is thrown in plastic lumps into an annular space which is formed in the interior of the vessel by the introduction of a cast-iron shell, within which a fire is placed. The basic material as soon as it becomes hot melts, and naturally fills up the annular space, and becomes quite solid after prolonged heating. Another method was to make bricks of this plastic material, in either cast- or wrought-iron moulds, which, while in their moulds, are placed in an oven and baked, when the tar is coked and the material becomes converted into solid bricks. After cooling, the mould is removed, and the bricks of perfect shape are simply built round the inside of the converter without any mortar whatever. When the vessel is ready molten pig is run in, and the converter being turned up the blow begins.

The following analyses of the metal charged during the ordinary acidic process were then exhibited:—

	Metal used 15 years ago.	Metal used now.
Carbon ..	3·5 to 4·0 per cent.	3·0 to 4·0 per cent.
Manganese	0·1 ,, 1·0 ,,	0·1 ,, 1·0 ,,
Silicon ..	2·0 ,, 3·0 ,,	2·0 ,, 3·0 ,,
Sulphur ..	0·01 ,, 0·05 ,,	0·05 ,, 0·15 ,,
Phosphorus	0·03 ,, 0·10 ,,	0·03 ,, 0·10 ,,

The Lecturer pointed out that many years ago only such spiegeleisen as contained between 9 and 10 per cent of manganese was available for Bessemer purposes, and the amount of manganese which it was possible to add, without making the steel too hard, was limited. Consequently the metal was required to be particularly low in sulphur, for it was a well-known fact that the effect of sulphur upon steel is to make it red-short, so that it breaks when rolling. Manganese had precisely the reverse effect. The quantity of the latter required to neutralise the injurious effect of sulphur was from six to eight times its weight; and the old German spiegeleisen being capable only of adding from 0·35 to 0·4 per cent of manganese, it was clear that the metal to work well should not contain more than 0·05 per cent of sulphur. At the present time, however, since the manufacture of better class English spiegeleisen, as much as 20 per cent of manganese is obtained, and by increasing the proportion of manganese added to the steel a very much larger quantity of sulphur is admissible. Hence it is possible to make excellent steel now with metal which a few years ago would have been condemned as utterly unsuitable for Bessemer purposes. During the blow their first object was to rid the metal of its carbon and silicon, which was performed in from twenty to twenty-five minutes. The following approximate table was then shown:—

	At the Start. Per ct.	After 5 mins. Per ct.	10′. Per ct.	15′. Per ct.	20′. Per ct.	25′.
Carbon ..	3·5	3·6	3·3	3·25	2·0	trace
Silicon ..	2·25	1·0	0·5	0·2	0·1	trace
Manganese	1·00	0·35	0·2	trace	—	—

Thus they would see that the manganese all went in fifteen minutes; the silicon began to go immediately, and continued to burn away at about the same rate throughout, while the carbon did not begin to diminish appreciably until all the manganese had gone and nearly all the silicon. At first it seemed as though the carbon increased, but this was not so; the carbon remained about the same in amount, and, as the quantity of other things diminished, its proportion to the whole was of course increased.

The Lecturer then showed the following, which is a table similar to the foregoing, showing the action when very siliceous pig-iron is used:

	At the Start. Per ct.	After 5 mins. Per ct.	10′. Per ct.	15′. Per ct.	20′. Per ct.	25′. Per ct.
Carbon ..	3·5	3·6	3·3	2·5	1·0	trace
Silicon ..	3·0	1·75	0·25	0·9	0·7	0·5
Manganese	0·75	0·25	trace	—	—	—

Here again it would be seen that the manganese disappeared first; the silicon began at once to go rapidly,—so rapidly, indeed, that the very great heat caused the carbon to commence to burn away sooner than usual, and the carbon disappeared almost while there was a small percentage of silicon yet remaining. This was what was called a hot blow, and it was desirable during a heat of this kind to add cold material. With such metal as this the blower is able, from previous knowledge, to ascertain a considerable time before the end of the process that the temperature is going to be excessive, and in such cases he reduces the temperature by the addition of cold scrap or pig-metal. When the temperature is not excessive the silicon entirely disappears before the carbon; consequently the whole of the oxygen entering at the bottom of the bath goes to burn the last traces of carbon, which is therefore very rapidly effected, and the large flame of carbonic oxide at the mouth of the vessel suddenly drops, indicating at once to the blower that the operation is ended. But when silicon is present during the elimination of the last traces of carbon, the flame does not drop so suddenly, for the oxygen is then divided in its action between silicon and carbon. Consequently the burning of the last parts of carbon is not so rapid, and the flame, instead of falling suddenly, fades gradually away. When this happens the blower knows that he has silicon left in the bath, and continues to blow until dense brown fumes appear, which is an indication that the oxygen entering at the tuyeres, after burning all the silicon, is commencing to burn the iron. The sulphur and the phosphorus in the ordinary acidic process are not affected to any extent; they apparently increase, but this is only relative, and is owing to the disappearance of the other ingredients. It would be observed, from the foregoing remarks, that as the temperature of the metal increases the relative attractions of silicon and carbon for oxygen approach each other. At first, when the metal is cool, the whole of the oxygen, practically speaking, is taken up by oxidising silicon; but after a certain period, when the temperature is considerably increased, the carbon begins to burn along with the silicon, and towards the end of the blow it will be seen, from the analysis of the siliceous blow, that the attraction of carbon for oxygen is as great or greater than that of silicon. This question of temperature is of the very greatest importance in making steel castings free from blowholes, for if the carbon has a greater attraction for oxygen than silicon has, the addition of silicon to the bath for the purpose of producing sound steel will be of no benefit whatever, and that the so-called Terrenoire process of making sound castings must necessarily depend as much upon the correct temperature of the metal as upon the chemical constituents.

The Lecturer here strongly advised that very much greater attention should be paid to the proper adjustment of temperature at the time of casting, in order that uniformly solid and homogeneous steel might be produced.

The Lecturer then turned his attention to the Basic

process, and exhibited upon the screen the following table, showing the composition of the metals commonly used in that process :—

Metals for Basic Process.

	No. 1.	No. 2.
Carbon ..	3·35 per cent.	3·50 per cent.
Manganese	0·60 ,,	1·00 ,,
Silicon ..	1·30 ,,	1·00 ,,
Sulphur ..	0·15 ,,	0·12 ,,
Phosphorus	1·75 ,,	2·75 ,,

As they would see, the special difference between this metal and that which was charged in the ordinary converter was the large percentage of phosphorus, and it was to effect the removal of this element that the basic system was called into existence. When the metal is charged into the vessel about 15 to 17 per cent of well-burned lime is also put in, for the purpose of absorbing the silica and phosphoric acid, produced by the oxidation of silicon and phosphorus, which, if no lime were present, would assert themselves by eating away the lining of the converter, which would in such a case be rapidly destroyed. Later on he would endeavour to explain why it was that the old process failed to remove the phosphorus. He then showed a table giving the approximate rates at which the various substances disappeared from phosphoric pig-iron during the blow :—

	At the Start.	After 5 mins.	10'.	15'.	18'.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Carbon	3·50	3·55	2·35	0·07	trace
Silicon	1·50	0 50	0·09	trace	—
Manganese ..	0·71	0·56	0·27	0·12	trace
Phosphorus ..	1·57	1·60	1·43	1·22	0·08
Sulphur	0·16	0 14	0·13	0·12	0·10

From this it would be seen that, as in the ordinary acid process, the carbon at first increases slightly, and afterwards rapidly burns away, while the silicon is speedily eliminated during the first few minutes of the blow. The manganese also is burnt out before the end of the operation, but not quite as rapidly as in the acid-lined vessel. Practically no phosphorus is eliminated until the whole of the carbon has been removed. The reactions which really take place in the basic process had been very carefully and systematically investigated by himself, and were of great interest to those concerned in the chemistry of the process. The Bessemer converter had always been classed as a great oxidising apparatus, and looking at it as a whole it was so; but it would be quite as logical to state that the blast-furnace, which they all considered to be a reducing machine, was also an oxidising apparatus. The fact was that they were both oxidising and reducing. In the blast-furnace the oxygen entering in at the tuyeres oxidised the carbon in the coke producing heat; but in the higher reaches of the furnace the gases so formed and the unoxidised carbon were very powerful reducing agents, and effected perfect reduction of the iron ore charged. In the Bessemer converter they also had a lower or oxidising part, and an upper reducing region. At the lower part, near the tuyeres, the oxygen rapidly entered into combination, not, as some would suppose, with the elements exactly as in the order shown in the ultimate analytical tables, but with the whole of the constituents all together in the proportion in which they were present, producing a very highly basic oxide of iron cinder. This cinder, passing upwards through the column of metal which—owing to the rushing of air through it—is in violent agitation, reacts upon the silicon and manganese, and at the same time also upon phosphorus, producing silicate of iron, silicate of manganese, and phosphate of iron. As the cinder was more and more intimately brought into contact with fresh portions of metal, the greater part of the oxide of iron was reduced, the iron returning to the bath at the same time that the silicon and manganese were oxidised. These reactions might very briefly be described by means of chemical symbols, thus :—

1. $Air + Fe_n = FeO + N.$
2. $2FeO + Si = SiO_2 + Fe_2.$
3. $FeO + Mn = MnO + Fe.$
4. $6FeO + 2P = FeO,P_2O_5 + 5Fe.$
5. $FeO,P_2O_5 + 6C = Fe + P_2 + 6CO.$
6. $FeO,P_2O_5 + 3Si = 3SiO_2 + P_2 + Fe.$

It would be seen from the last two reactions, Nos. 5 and 6, that as long as carbon and silicon existed in the bath, there being a large head of metal over the tuyeres, practically no phosphorus could be eliminated. If, however, the bath was shallow, or the tuyeres were caused to inject air forcibly upon the surface of the metal, there being on the surface at the same time a quantity of lime ready to absorb any silicic or phosphoric acid produced, the phosphorus might be and had been perfectly removed before the elimination of the carbon. Thus at the Blaenavon Works, where Messrs. Thomas and Gilchrist made their first experiments in a stationary converter in which the tuyeres were certainly not more than a few inches from the surface of the metal, in almost every case the whole —or at least a very great proportion—of the phosphorus was eliminated by the time that the last portions of carbon were removed from the bath. The question might be asked why the oxide of iron produced by surface oxidation is not reduced, remembering that the metal during the blowing process must necessarily be in a violent state of agitation, and therefore brought into intimate contact with the cinder formed at the surface? The explanation was very simple. When the phosphate of iron was formed at the top of the bath it instantly afterwards came into contact with highly heated lime, which completely decomposed it, phosphate of iron and lime reacting on each other and forming phosphate of lime and free oxide of iron, and this phosphate of lime was incapable of reduction by the carbon in iron or by carbonic oxide gas. Hence no reduction took place. From the point of the termination of blowing forward the operations in the acid and basic processes were similar, only in the case of basic steel the greater part of the surplus oxygen contained in the bath was removed by Mr. E. W. Richards's process, of adding fluid hematite pig-iron containing silicon. To the blown metal was added spiegeleisen, by means of which the necessary carbon and manganese were put back into the metal (and by means of which, in the case of acidic steel, the surplus oxygen was also removed), which was thereby converted into malleable steel. The following analysis of spiegeleisen were then exhibited :—

	Old German.	New English.
Carbon ..	4·50 per cent.	5·20 per cent.
Manganese	10·00 ,,	20·00 ,,
Silicon ..	0·50 ,,	0·50 ,,
Sulphur ..	trace	trace
Phosphorus	0·10 ,,	0·10 ,,

The Lecturer then went on to explain the reason why phosphorus could not be removed in the ordinary silica or acid converter, and to make his explanation perfectly clear he placed upon the screen the following equations :—

$$3CaO,P_2O_5 + 3SiO_2 = 3CaO,SiO_2 + P_2O_5.$$
$$FeO,P_2O_5 + SiO_2 = FeO,SiO_2 + P_2O_5.$$
$$P_2O_5 + 5Fe = 5FeO + P_2.$$

These reactions showed that phosphate of iron or lime, if formed in the presence of silica, were decomposed, silicate of iron or lime being formed, and free phosphoric acid being produced. But this free phosphoric acid could not exist as such, but was reduced not only by the carbon and silicon, but even by the metallic iron itself. The Lecturer explained that if a rod of pure iron was simply dipped in phosphoric acid, and heated to redness while in contact with it, a fusible drop of phosphide of iron would form at the extremity of the rod.

The Lecturer then placed upon the screen comparative analyses of the slags produced in the two processes, which were as follows :—

	Ordinary Slag. Per cent.	Basic Slag. Per cent.
Protoxide of iron (FeO) ..	15·62	9·13
Peroxide of iron (Fe_2O_3) ..	1·57	—
Metallic iron (Fe)	—	—
Alumina (Al_2O_3)	1·02	2·10
Oxide of manganese (MnO)	5·33	4·32
Silica (SiO_2)..	75·70	16·60
Lime (CaO)	0·94	47·08
Oxide of magnesia (MgO)..	0·09	4 62
Sulphur (S)	0·01	0·12
Phosphoric acid (P_2O_5) ..	Nil.	16·03
Bases	14·57	65·15
Acids	75·71	34·85

Referring to the loss or waste in Bessemer converting, the Lecturer explained that a very great proportion of the present waste was due to projections from the nose of the vessel, which was liable to be carried away with the rubbish of the Bessemer house. An analysis of an accumulated mass of such projections was exhibited, as follows :—

Bessemer Projections.

	Per cent.
Free iron (Fe)	70·30
Peroxide of iron (Fe_2O_3) ..	14·50
Manganese (Mn)	0·11
Carbon	1·01
Silicon	0·63
Sand	13·18
Phosphorus	0·05
Sulphur	0·06

The Lecturer pointed out that, according to careful analytical data, not more than 2 per cent of the metallic iron in the charge was actually burnt, and that if no loss occurred, either in projections, scrap, or iron mechanically carried away entangled in the slag, the yield of steel should be 92·5 per cent of the metal charged. In practice, however, the yield averaged from 3 to 4 per cent less than this. In the basic converter the theoretical yield was about 2 per cent less than from the ordinary vessel, but in practice, owing to the large amount of slag produced, more particles of metallic iron were liable to be carried away with the slag, so that a yield of 85 per cent was considered very satisfactory.

The last slide exhibited was to show the comparative composition of Basic steel and ordinary Acidic steel, as follows :—

	Acid.	Basic.
Iron	98·33 per cent.	98·46 per cent.
Carbon ..	0·35 ,,	0·35 ,,
Manganese	1·11 ,,	1 01 ,,
Silicon ..	0·08 ,,	0·03 ,,
Sulphur ..	0·06 ,,	0·11 ,,
Phosphorus	0·05 ,,	0·04 ,,
Copper ..	0·02 ,,	trace

From these it would be seen that the steel produced is very similar in both cases.

In conclusion, the Lecturer remarked that the Basic process was making rapid progress in a commercial sense, not so much in this country (although there were several new works being arranged for the process near completion) as on the Continent. Mr. Gilchrist, one of the patentees, had recently estimated that the make of that steel last year, everywhere, was about half a million tons, and that the make of the forthcoming year would probably double that quantity.

Graphite-baths.—F. Stolba proposes graphite in place of sand, as it does not scratch glass vessels, and is more readily heated.—*Zeitschrift fur Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, Friday, March 30, 1883.

Dr. Gilbert, F.R.S., President, in the Chair.

The President read his annual report. There have been occasions in the history of the Society when important questions had to be discussed, sometimes involving matters of internal working and management, at others the consideration of some new departure with a view to more extended usefulness. At present there are no such questions requiring special notice; the attainment of the objects for which the Society was founded is steadily progressing, and the President, taking advantage of the fact that he was elected a Fellow during the first session of the Society, now nearly forty-two years ago, presents the Society with a review of its progress from the commencement of its existence up to the present time. Of the 25 gentlemen who met on February 23, 1841, for the formation of the Society, only two now remain in the list of the Fellows, and out of the 118 members on the register at the first anniversary meeting, March 30, 1842, only 10 could now answer the roll-call—The President, Prof. Andrews, Drs. De la Rue, Longstaff, Lyon Playfair, James Young, and Messrs. Heisch, F. R. Hughes, Pearsall, and Denham Smith. The number of Fellows at the last anniversary was 1175; 104 have joined during the past session. Nine have died—Mr. John Gray, Mr. Dugald Campbell, Mr. J. J. B. J. Grosjean, Mr. A. Jesseman, Dr. G. A. C. Pearce, Dr. G. W. Septimus Piesse, Mr. E. Wilcock, Prof. H. J. S. Smith, and Mr. Frank Hatton; 23 have withdrawn, &c., so that the present number of Fellows on the register is 1247. One foreign member, F. Wöhler, is deceased, whilst nine have been elected, the total number of foreign members being now 37. The objects of the Society, as stated by the Founders, were the reading, discussion, and subsequent publication of original communications, and the formation of a chemical library and museum. The number of papers read during the five years ending 1846 was 167, giving an annual average of about 33; in 1854-55 only 17 papers were read; during the past session 70 papers were communicated to the Society, and one discourse, "On the Recent Development of the Theory of Dissociation," was given by Prof. Dewar. As to the Journal, 1775 copies were printed during the past year. About 1851, an attempt was made to found a museum in connection with the Society, and some specimens were sent from the great Exhibition, but were eventually again dispersed. The President suggests that as a nucleus of a future museum, the authors of papers on new compounds might be requested to present specimens to the Society. A much more favourable account can be given of the Library. At the time the last catalogue was issued to the Fellows in 1873, the number of volumes was 3540; since that time 3260 volumes have been added, making a total of 6800. During the same period the number of pamphlets has increased from 540 to 840. The Council have decided that a new catalogue arranged in order of subjects shall be prepared, printed, and issued to the Fellows as soon as possible. The income of the Society has steadily increased from about £183 in 1846 to over £3000. The Report then dwells upon the vast facilities for the study of chemistry which are now afforded in all parts of the country, so that while less than fifty years ago there was no systematic course of analytical training in the kingdom, now almost every public school has some arrangements for teaching practical chemistry. With this great development in the past, and all that it promises in the future, there is surely every reason to believe that the Society must increase both in the number of Fellows and in the

number and value of the papers communicated to it. There have been two off-shoots from the Society during the last few years—The Institute of Chemistry and the Society of Chemical Industry; but neither has prospered at the expense of the parent Society. The valuable papers which have been published by the Society of Chemical Industry have probably been originated altogether under the auspices of the new society, and are, so far, a pure gain, rather than a transference of energy. The President then concludes this portion of the Report with a most interesting *resumé* of the arrangements for chemical education and chemical research on the American Continent, founded upon the experience gained during his recent tour in that country, and on information received from Sir A. Galt, High Commissioner for Canada, and from His Excellency, Mr. Lowell, the American Minister in London.

Dr. SCHUNCK said that all must regret that Dr. Gilbert was not in a position to accept the office to which he had been nominated by the Council. The Fellows were much indebted to him for his constant attendance and courtesy. He had much pleasure in proposing a hearty vote of thanks to Dr. Gilbert, and that his report be adopted.

This was seconded by Prof. RONALDS and carried unanimously.

Dr. GILBERT said that he appreciated very highly the honour of having been President, and most sincerely regretted that in consequence of the pressure of his own avocation and his distance from London, he had been compelled to relinquish the office at the end of the first year. His successor was a tried officer of the Society, and had by his researches contributed largely to the interest of the meetings and of the Journal, and it seemed only fitting that a chemist who had devoted himself specially to organic chemistry should fill the Chair when that branch of the science was so constantly brought forward at the meetings of the Society.

The TREASURER then presented his Report. The total income of the Society was about £3073, the expenditure about £2770, leaving a surplus of £303. This surplus was rather smaller than last year for several reasons. There had been an increase in the expenses connected with the Journal of £217; with the Library of £61; the income was also rather less than was anticipated, owing to the fact that a smaller proportion than usual of the new Fellows had compounded. Next year there would probably be no surplus, as it would be taken up by the expenses connected with the new catalogue and the redecoration of the Society's rooms. The assets of the Society consisted of £7788 stock, and a balance at the Bank of £1194. As to the Research Fund, £220 had been given in grants during the year. The assets consist of £4500 stock, and a balance at the Bank of £166. The donations to the Fund had fallen off considerably.

Mr. WARINGTON proposed a vote of thanks to the Treasurer, which was seconded by Mr. MAKINS, and carried unanimously.

Votes of thanks were also given to the Auditors, the Council and Officers, and the Editor, Sub-editor, and Abstractors.

Messrs. W. Thorp and Newlands were then nominated Scrutators, and the following Officers and Council were declared duly elected:—

President—W. H. Perkin, Ph.D., F.R.S.

Vice-Presidents—F. A. Abel, Warren De la Rue, E. Frankland, J. H. Gilbert, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, H. E. Roscoe, A. W. Williamson, A. Crum-Brown, P. Griess, G. D. Liveing, J. E. Reynolds, E. Schunck, A. Voelcker.

Secretaries—H. E. Armstrong, J. Millar Thomson.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Council—E. Atkinson, Capt. Abney, H. T. Brown, W. R. E. Hodgkinson, D. Howard, F. R. Japp, H. McLeod, G. H. Makins, R. Meldola, E. J. Mills, C. O'Sullivan, C. Schorlemmer.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, April 2, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

ARTHUR GOULSTON, Jun., B.A. Cantab., and R. Raymond Mège were elected Members of the Royal Institution.

Three candidates for Membership were proposed for election.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Programm der Königlichen Technischen Hochschule zu Aachen fnr das Sudien Jahr, 1882-1883. (Programme of the Royal Technical High School at Aix-la-Chapelle.) Aachen: E. N. Palm.

THIS celebrated institution continues to flourish in undiminished efficiency. It is impossible to study the arrangements without feeling what a task lies before us if we wish to provide our practical men with a course of technological training such as is to be had in Germany. We are not in want of the needful funds, nor of qualified men as teachers, but so long as we cling to our peculiar notions concerning education, all this profits, and can profit, us nothing. There are in the Aachen Technical School, five divisions, corresponding to the faculties in a university, and every pupil on entering has to select his faculty. The full course of instruction lasts four years. As in all German colleges, examinations, though occurring at the end of each year, are considered not as an end, but merely as a means of ascertaining the progress of the students. Turning to the Chemical Division, or faculty, we find that Professor Classen, assisted by Drs. Halberstadt and Bauer, gives instructions for four hours weekly in the summer term, and for one hour in forensic chemistry. In the winter term he gives one hour weekly in volumetric analysis, and two hours experimental chemistry. Practical work in chemistry, both qualitative and quantitative, is carried on daily in his laboratory from 8 a.m. to 6 p.m., except on Saturday. Professor Michaelis lectures six hours weekly on experimental chemistry, and his laboratory is also open for organic work from 8 a.m. to 6 p.m. Professor Stahlschmidt, assisted by Dr. Stengel, lectures on technical chemistry for four hours, on planning and arranging chemical works for four hours, whilst his laboratory is also open from 8 to 6 daily, except Saturday. Dr. Von Reis teaches technical gas analysis. Dr. La Coste lectures for two hours weekly on systematic organic chemistry, taking the fatty series in winter and the aromatic compounds in summer. He also reads the history of chemistry, and holds what is called a "chemical colloquium."

This brief outline may give some idea of the thoroughness which pervades the whole establishment, and may show what our technical schools, science colleges, &c., must equal, or, if possible, surpass, if we are to hold a fair position in the industrial world.

Dr. Theodor Schuchardt's Chemische Fabrik, Goerlitz. Winter Semester, 1882-83.

WE have here a catalogue and price list of the numerous chemical preparations produced in the celebrated establishment of Dr. Schuchardt. The number of the products offered for sale and the very reasonable prices of many rarities are worthy of notice. Experimentalists will therefore often find it of advantage to refer to this cata-

logue. A great inconvenience is that the author has seen fit to employ not the terminology of pure chemistry, but that of pharmacy. Thus the substances generally known as chlorides, iodides, bromides, &c., figure here as chlorates, iodates, and bromates; and, on the other hand, the compounds of chloric, iodic, and bromic acids figure, *e.g.*, as natrium (sodium), chloricum, bromicum, &c. We should think that not a few mistakes must arise from this peculiarity.

The catalogue also includes lists of standard volumetric solution, given, fortunately, in good German, and not in *quasi* Latin; sets of analytical apparatus, among which we note a set for the detection of poisonous or hurtful pigments on paper hangings, wooden toys, confectionery, &c.; further collections of metals, of the elements, of fluorescent solutions; of preparations for spectroscopic examinations; sets of alkaloids, of coal-tar colours, physiological collections, select crystals, models of crystals, collections of rare vegetable drugs, collections of minerals, and volumetric and general chemical apparatus.

On the Part of Salicylic Acid in the Formation of Salts with Medicinal Bases. By A. SCHLUMBERGER. Paris: Felix Malteste et Cie.

THIS pamphlet, which is reprinted from the *Transactions* of the French Association for the Advancement of Sciences, is medical rather than chemical in its subjects and intentions. The author proposes that the salts of quinine, zinc, lithium, bismuth, iron, &c., for medicinal use should be formed not with the "traditional mineral acids," but with salicylic acid, or of some other antiseptic acid of the aromatic series.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 11, March 12, 1883.

Speed of the Explosive Wave.—M. Berthelot.—A mathematical paper, not suitable for abstraction.

A Crystalline Aluminium Borate from Siberia.—A. Damour.—This new mineral species has been found in the Soktoui mountains, near Adoun-Tchilon, by M. Jeremeiew, and has received the name Jeremeiewite. The author assigns it the formula Al_2O_3,BO_3, but it contains 4·08 per cent ferric oxide, and 0·70 potassa.

Polarisation of Diffracted Light.—M. Gouy.—This memoir requires the accompanying diagram.

Indices of Refraction of Gases under High Degrees of Pressure.—J. Chappuis and C. Rivière.—This paper does not admit of useful abstraction.

Production of Certain Crystalline Stannates.—A. Ditte.—A solution of potassium stannate poured into an excess of calcium chloride gives a white gelatinous precipitate, which at 100° changes into small, colourless, cubic crystals, containing 5 mols. of water. An anhydrous calcium stannate may be obtained in crystals by keeping a mixture of stannic oxide, calcium chloride, and a little lime at a white-red heat for several hours, washing the mass, and treating it with weak hydrochloric acid. The author has obtained strontium, barium, nickel, cobalt, zinc, silver, and copper stannates in crystals, all of which are insoluble in water, but in the hydrated state dissolve in dilute acids.

Ammoniacal Bromides and Zinc Oxy-bromides.—G. André.—The author gives the method of preparation and the analysis of several zinc ammonium bromides, and of three oxy-bromides of the same metal.

Double Ortho-Phosphates of Barium and Potassium, and of Barium and Sodium.—A. de Schulten.—The author obtains these compounds by heating to a boil a mixture of alkaline silicate and of baryta water, and then adds a solution of alkaline silicate holding a certain quantity of alkaline phosphate in solution. On cooling the liquid the new compounds are obtained in crystals. If caustic alkali is used instead of the silicate the product is an amorphous precipitate.

Chromium Selenite.—C. Taquet.—On treating chromium chloride at a boil with potassium selenite the author obtained a pale green, bulky precipitate, which, when washed and dried, has the composition $Cr_2O_3,3SeO_2$. It is soluble in hot hydrochloric acid, insoluble, or scarcely soluble, in water, and slightly soluble in a boiling excess of selenious acid.

Vapour-Tensions of Ethylamine and Diethylamine Hydrosulphates.—M. Isambert.—The author refers to his paper, *Comptes Rendus*, xciv., p. 958, where he shows that the vapour-tension of ammonium hydrocyanate in presence of an excess of hydrocyanic acid, is the same as that of free hydrocyanic acid at all temperatures, notwithstanding the presence in the vapour of free or combined ammoniacal gas. He finds that with diethylamine hydrosulphate the law is the same, but with the ethylamine compound the results are strikingly different.

Salts formed by Glycolic Acid.—M. de Forcrand.—Glycolic acid forms with bases, three series of salts,—neutral salts, stable in presence of water; acid salts, decomposable in great part by water; and basic salts, which are at the same time neutral salts and alcoholates, and are decomposed by water, like the acid salts.

An Aromatic Tribrom-hydrine.—A. Colson.—The author has obtained and examined three compounds produced on treating mesitylene by bromine.

Mechanism of the "Setting" of Gypsum.—H. le Chatellier.—This setting is the result of two distinct, though simultaneous, phenomena. On the one hand, portions of anhydrous calcium sulphate, when moistened with water, dissolve as they are hydrated, forming a supersaturated solution. On the other hand, this same solution deposits crystals of the hydrated sulphate, gradually augment in bulk, and unite together.

Moniteur Scientifique, Quesneville. February, 1883.

Industrial Review.—An account of various industrial processes, taken from the CHEMICAL NEWS, the *Journal of the Society of Chemical Industry*, *Liebig's Annalen*, &c.

Carbides of Petroleum as Sources of Benzol, Naphthaline, and Anthracene.—Professor Liebermann.—This memoir refers chiefly to the petroleum of the Caucasus. The firm of Nobel Bros., of Baku, have erected extensive works for obtaining the above products from petroleum refuse. They calculate for the present year upon producing 42,000 kilos. of crude anthracene, and 500,000 kilos. of benzol at 80 per cent.

A New Method of Carburetting Lighting-Gas.—A. Remont.—The agent used is naphthaline purified in a peculiar manner, patented by MM. Vale and Roosevelt.

The remaining papers in this issue are taken from the *Zeitschrift für Analytische Chemie*, and have been or will be duly noticed under that head.

Zeitschrift für Analytische Chemie. Vol. xxii., Part 1, 1883.

New Method of Separating Vanadic Acid from Metals.—W. Halberstadt.—Already noticed.

Method for Determining Hydrochloric, Hydrobromic, and Hydriodic Acids in Solutions which Contain Sulphuretted Hydrogen.—Haldor Topsoe.—This paper will be inserted at length.

Separation of Strontium and Calcium.—D. Sidersky.—The author's method is carried out as follows:—A few grms. of the sample in question (*e.g.*, finely-ground strontianite) are dissolved in a roomy beaker in a minimum of hydrochloric acid, and boiled for a time; all the strontia, including that combined with silicic acid, is dissolved, whilst gelatinous silica is deposited. Ammonia in excess is next added, which precipitates oxide of iron and alumina, and the residue of the silica. This deposit is collected on a filter, washed with a minimum of water, dried, &c., and accounted for as "marl." The separate determination of its ingredients is of no practical importance. The filtrate must be concentrated on the water-bath, and mixed whilst warm with a mixture of ammonium oxalate and sulphate (prepared by dissolving 200 grms. sulphate and 30 oxalate in 1 litre of water), which throws down strontium sulphate and calcium oxalate. A large excess of the reagent is to be avoided. The precipitate is carefully brought upon a filter, washed first with warm water, and then with dilute hydrochloric acid, which dissolves calcium oxalate, leaving strontium sulphate behind. The latter is washed to remove the acid, dried, ignited, and weighed. The filtrate is mixed with ammonium oxalate in excess, whereby the calcium oxalate is re-precipitated. It is then washed, dried, converted into caustic lime by ignition over the blast-lamp, and weighed.

Quantitative Analysis of Human Milk with an Appendix on Cow's Milk.—Dr. E. Pfeiffer.—The author determines the caseine by precipitation with about 3 drops hydrochloric acid (of sp. gr. 1·0020) to 2 c.c. The tube containing the milk should be plunged into water at about 62° to 68°. If the first drops pass through the filter turbid they are returned to the tube well shaken up, and again poured upon the filter. When all has passed through clear, the filter is dried, freed from fat in a Soxhlet-Szombathy ether apparatus, dried again, and weighed. The determination of the albumen is effected by boiling the filtrate obtained in the last operation. The coagulum is filtered off, washed, dried, and weighed. In the filtrate the "albumenoid residue" is determined by adding a few c.c. of a 10 per cent solution of tannin. This residue is not a peculiarity of human milk. In cow's milk the author found—caseine, 2·329 per cent; albumen, 0·224; and albumenoid residue, 0·731 per cent.

A New Method for Determining Nitric Oxide or Nitric Acid.—Dr. C. Bœhmer.

Proposed Method for Determining Carbonic Acid and Nitrogen in Certain Combinations.—K. Sondén.—These two papers require the accompanying illustrations.

A Burette for Liquids which Attack Caoutchouc.—Karl Abraham.

Separating Funnel and Apparatus for the Determination of Fat.—A. Gawalovski.—Neither of the above two memoirs can be usefully abstracted without the accompanying illustrations.

Preservation of Ferrous Sulphate.—A. Gawalovski.—The author plunges in among the crystals a very stout test-tube, half filled with an alkaline solution of pyrogallic acid, and with its mouth sufficiently high above the mass. If the bottle is well stoppered, a sample so protected remains unaltered for two or three years.

Examination of Liqueurs.—Dr. J. Nessler and Dr. M. Barth.—The authors treat at length of the cherry and sloe brandies of Baden, the method of distillation, the different qualities, and the determination of alcohol, acids, lime, copper, and hydrocyanic acid. Copper may be present to the extent of 18 m.grms. per litre, the quantity being greatest when much acetic acid has been formed during the fermentation.

Determination of the End of the Reaction with Fehling's Solution in very Dilute Solutions of Sugar.—Dr. J. Moritz.—The author passes one or two drops of the liquid through a small filter upon a white porcelain plate, and tests for copper in the usual manner with acetic acid and potassium ferrocyanide. If there remains the slightest trace of undecomposed salt of cupric oxide, there is formed a reddish brown film of copper ferrocyanide, which shows very distinctly against the white plate.

Interference of the Salts of the Alkaline Earths with the Sulphocyanide Iron Reaction.—Hermann Weber.—The author had treated a residue containing potassium chlorate and chloride, calcium chloride, and traces of iron with nitric acid in order to oxidise the latter, and had heated the liquid until all chlorine was expelled. When the liquid was cold it gave the usual reaction with potassium ferrocyanide, but not with sulphocyanide. Further experiments showed that the chlorides of the alkaline earths enfeeble the reaction of the sulphocyanides with iron, and if present in excess can prevent it altogether. Calcium chloride has a more powerful action than the corresponding salts of strontium and barium. The nitrates of the alkaline earths interfere also, but in a slighter degree.

Analysis of Natural Wines.—R. Fresenius and E. Bergmann.—The authors determine the proportion of the various ingredients of wines to each other, showing the limits within which they may vary.

The Relation between Glycerin and Alcohol in Wine.—E. Bergmann.—Wines in which the glycerin bears a less proportion to the alcohol than 7 : 100 may be regarded as artificially fortified.

Washing Bottle for Hot Water.—E. Bergmann.—This short notice requires the accompanying figure.

Different Spectra of the Non-Metals.—D. van Monckhoven.—From the *Comptes Rendus*.

The Capacity of Gases for Absorbing Heat.—H. Heine.—The author has sought to utilise this capacity for determining the constituents of gaseous mixtures.

Mechanical Separation of Different Minerals.—C. Dölter.—The author makes use of an electro-magnet, regulating its power according to the case. He notes that iron sulphides, sulphates, and carbonates are attracted less strongly than the oxides, carbonates, and silicates. L. Pebal considers it preferable to apply magnetic action to powders suspended in water, instead of operating, as does Dölter, on the dry powder.

Combustion of Carbon in Organic Incinerations.—E. Johanson.—The author proposes when the carbon is glowing to let the crucible cool until the incandescence ceases, and heat again, alternating in this manner until the ash is of a pure white. The process is said to be thus effected more rapidly than by continuous ignition.

New Wedge Compensation in Polarising Apparatus.—Schmidt H. Hänsch.—For a description of this apparatus the reader is referred to the original memoir.

Covering-glasses in the Tubes of Polarising Apparatus.—W. Poppe.—The author calls attention to the known fact that covering-plates if too strongly pressed become double refractive.

Balances and Weighing.—W. Dittmar discusses theoretically the factors on which the sensitiveness of the chemical balance depends, and in another memoir describes a microscopic arrangement for reading off the indications of sensitive balances.

W. J. Marck treats of the effect of small differences of pressure upon the results of delicate weighings and measurements.

G. Schwirkus points out that in reducing determinations of weight to a vacuum the specific gravity of pure air is taken as a basis, whilst the weighing is generally performed in air modified by the products of human respiration, the combustion of lamps, &c. He also considers

the influence of the porosity of weights upon their permanence. He also proposes a new method of fixing the knife-edges, which he explains by a figure.

L. Löwenherz considers the torsion of wires as a means of determining small weights.

F. Sartorius proposes a new apparatus for checking oscillation.

Paul Bunge has constructed an analytical steel-yard, which is said to be not inferior in sensibility to the ordinary balance, whilst much less time is required in weighing.

Thermometers.—MM. Pernet, Crafts, E. J. Mills, T. E. Thorpe, A. W. Rücker, and others, have proposed modifications in thermometers, or studied the defects of the instruments now in use.

L. W. Andrews describes and figures a thermometer for temperatures extending above the mercurial scale.

Determination of Melting-points.—Guichard melts the substance in question, sucks it into a capillary tube open at both ends and slightly widened at top up to the middle, and allows it to congeal. The space above is then filled with a coloured liquid which does not attack the substance, and the little tube is heated along with the thermometer in the usual manner. At the moment of melting, the coloured fluid runs off, and the temperature is read off. It is questionable whether, in many cases, the efflux may not be hindered by capillarity.

The arrangement of Messrs. C. F. Cross and E. J. Bevan is described in the CHEMICAL NEWS, vol. xlv., p. 39.

L. Liebermann, for determining the melting-points of alloys, plunges rods of the substance in question into a paraffin-bath, and includes them by means of wires in a galvanic circuit, into which a signal bell is introduced. As soon as the metal melts, the current is interrupted, the bell is silent, and the thermometer is read off.

Determination of Vapour-densities.—L. Valente proposes a modification of V. Meyer's apparatus. At the upper end of the tube projecting up out of the heating apparatus, a thick caoutchouc tube is fixed, closed below by an ordinary and above by a screw pinch-cock. Between the two is the small glass tube containing the substance. When the apparatus has reached the requisite temperature, the lower pinch-cock is opened, and the tube with its contents falls into the recipient.

Determination of the Specific Gravity of Liquids at their Boiling-point.—R. Schiff proposes modifications in the apparatus of Ramsay, described *Zeitschrift Anal. Chemie*, xix., 60.

Apparatus for Determining Solubilities at Different Temperatures.—F. Stolba.—The reader is referred to the original memoir (*Chem. Central-Blatt*, Series 3, vol. xi., p. 773).

New Gas Blast Lamp.—T. T. Morell.—From *New Remedies*.

A Modification of Weber's Mercurial Distillation Apparatus.—A. W. Wright.—From the CHEMICAL NEWS.

Filtering Apparatus.—P. Casamajor.—From the CHEMICAL NEWS.

A Water-bath with a Constant Level.—F. Schimmel.—The boiling vessel is connected with a closed reservoir by two tubes in the same manner as in arrangements for the continuous washing of precipitates.

Preservation of Objects of Vulcanised Caoutchouc.—W. Hempel.—The author proposes to keep them in large glass boxes in which there is an open vessel of petroleum.

Preparation of a Durable Starch Solution for Iodometry.—A. Müller rubs up the starch with strong potassa lye. On diluting with water a clear solution is obtained which keeps for years. When using it care must be taken that the liquid to be titrated contains a slight excess of acid.

Preparation of Durable Tincture of Litmus.—Tincture prepared according to Mohr's formula is evaporated to dryness, and the residue is dissolved in a little glycerin. For use a glass rod is introduced into the tincture, and the liquid to be coloured is stirred with it.

Purification of Zinc.—To expel arsenic Selmi melts the zinc in a crucible, and throws in a piece of sal-ammoniac. All the arsenic passes off as arsenious chloride.

Preparation of Pure Silver Nitrate from Cupriferous Silver.—The alloy is dissolved in nitric acid, evaporated to dryness, melted, and reduced silver is stirred in as long as effervescence takes place. The copper is separated out, and silver takes its place, so that pure silver nitrate may be dissolved out and crystallised.

Evolution of Sulphuretted Hydrogen Gas.—A. Lidoff.—The author heats sulphur to the point of incipient sublimation in a suitable flask, and allows liquid oleonaphtha to flow in at the rate of 3 to 5 drops per minute. A rapid and regular emission of sulphuretted hydrogen is thus obtained.

The Permanence of Standard Solutions of Alkaline Hydrosulphites.—Spencer Umfreville Pickering.—From the CHEMICAL NEWS.

Methods of Preparing and Applying Molybdic Solution.—H. Kupferschlaeger.—From the *Bulletin de la Soc. Chimique de Paris*.

Preparation of Hydrobromic Acid, and its Use in Analytical Chemistry.—August Harding.—The author describes and figures an apparatus by means of which about 1 kilo. concentrated acid can be prepared per hour at about one-sixth the cost of the commercial product. The acid dissolves all the simple metallic sulphides, whether natural or artificial; if moderately strong it dissolves mercury, copper, and lead, with liberation of hydrogen gas, whilst the strongest acid dissolves considerable quantities of lead sulphide, which is re-precipitated on dilution with water. Hydrobromic acid is especially valuable for the determination of sulphur. In presence of pieces of amalgamated copper it converts sulphur, whether free or in the form of metallic sulphides, into hydrogen sulphide, which, if no carbonic acid is present, is dried over calcium chloride, and absorbed in a weighed soda-lime tube.

Detection of Carbon Monoxide.—J. v. Fodor.—A slip of Swedish filter-paper, saturated with a neutral solution of palladious chloride, turns grey on contact with carbon monoxide. The author mentions that hydrogen sulphide and ammonia produce the same colouration. Böttger also states that marsh-gas, ethylene, hydrogen, and coal-gas, also act upon the test-paper, whilst it is not affected by oxygen, nitrogen, carbon dioxide, and sulphur dioxide. Schneider confirms Böttger's statements, and remarks that in addition hydrogen sulphide, ammonium sulphide, and ozone blacken the palladium paper, whilst chlorine, hydrocyanic acid, nitrous acid, and ammonia produce no effect. We have here a contradiction of Fodor's results as far as ammonia is concerned, whence palladium chloride can only be used with caution as a reagent for carbon monoxide.

Determination of Alkaline Chlorides in Presence of an Excess of Magnesium Sulphate.—H. Precht and B. Wittjen.—The mixture is ignited with starch. The alkaline sulphides formed are easily extracted from the residue by lixiviation, whilst the magnesia remains undissolved.

Determination of Lithium in Presence of Excess of Potassium and Sodium Chlorides.—W. F. Gintl.—The author adds to the mixture 4 to 5 times its weight of hydrochloric acid, and heats for two hours on the water-bath, adding more acid to make up for the loss on evaporation. When cold the solution is decanted through a glass-wool filter which has been previously washed with hydrochloric acid. The residue is treated twice more with hydrochloric acid in the same manner, so as finally to bring the entire saline mass upon the filter, where it is washed with hydrochloric acid until a drop of

the liquid passing through no longer shows the presence of lithium when examined with the spectroscope. The filtrate is evaporated on the water-bath to 1-20th of its original volume ; about 3 parts of concentrated hydrochloric acid are added, and the sodium and potassium chlorides which separate out are removed by means of a glass-wool filter. The saline mixture is washed with a minimum of hydrochloric acid until the lithium reaction disappears. The solution obtained is freed from hydrochloric acid by evaporation, and contains all the lithium along with little potassium and less sodium. The lithium can then be determined as a basic phosphate in the ordinary manner.

MISCELLANEOUS.

Distillation in a Vacuum.—H. Schüller has observed the behaviour of 13 inorganic and 12 organic bodies when heated in a vacuum, their sublimations and distillations, and the nature of the residues. Many of the elements examined, especially selenium, tellurium, cadmium, zinc, magnesium, arsenic, and antimony, were capable of sublimation, while the very fusible metals, bismuth, lead, and tin, distilled with difficulty, the last-mentioned scarcely at a red heat. On the other hand, Demarçay found bismuth volatile at 292°, lead and tin at 360°, which Schüller explains by the presence of volatile impurities. During the whole time of the distillation of a metal an escape of gas was observed. But on repeated evaporation this phenomenon was imperceptible, or very slight. Sodium, selenium, tellurium, cadmium, zinc, arsenic, and antimony evaporate so readily in a vacuum that this method may be used for their purification. Amongst organic bodies many unstable mixtures, such as tallow, wax, and resin, distil so easily in a vacuum that they may thus be separated from impurities.—*Annalen der Physik*, N. S., xviii., p. 317.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Anhydrous Ammonia.—Can any of your readers furnish information as to the manufacturers of anhydrous ammonia? At atmospheric pressure it will of course be a gas, but under greater pressure a liquid.—T. P.

MEETINGS FOR THE WEEK.

MONDAY, April 9.—Medical, 8.30.
— Society of Arts, 8. Cantor Lectures. "The Decorative Treatment of Metal in Architecture," by George H. Birch, A.R.I.B.A.

TUESDAY, 10th.—Institution of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.

WEDNESDAY, 11th.—Society of Arts, 8. "The Portrush Railway and the Transmission of Power by Electricity," by Alexande Siemens and E. Hopkinson, D.Sc.
— Geological, 8.
— Microscopical, 8.

THURSDAY, 12th.—Royal Institution, 3. "Art of Pheidias," by Dr. Waldstein.
— Society of Arts, 8. "The Formation of Diastase from Grain by Moulds," by R. W. Atkinson, B.Sc.

FRIDAY, 13th.—Royal Institution. 8. "Influence of Athletic Games on Greek Art," by Dr. Waldstein, at 9.
— Astronomical, 8.
— Quekett Club, 8.

SATURDAY, 14th.—Royal Institution, 3, "Geographical Evolution," by Mr. A. Geikie.
— Physical, 3. "Some Uses of a New Projection Lantern.—Science Demonstration in Board Schools," by W. Lant Carpenter. "Experiments on the Viscosity of Saponine," by W. H. Stokes and A. E. Wilson.

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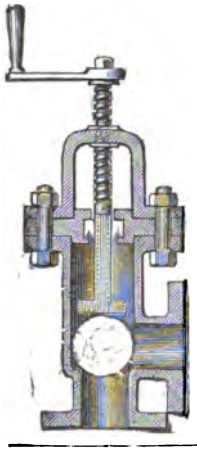

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1220.

RE-CONVERSION OF NITRO-GLYCERIN INTO GLYCERIN.

By C. L. BLOXAM.

The following experiments on this subject appear to possess some interest at the present moment:—

1. Nitro-glycerin was shaken with methylated alcohol, which dissolves it readily, and the solution was mixed with an alcoholic solution of KHS (prepared by dissolving KHO in methylated spirit, and saturating with H_2S gas). Considerable rise of temperature took place, the liquid became red, a large quantity of sulphur separated, and the nitro-glycerin was entirely decomposed.

2. Nitro-glycerin was shaken with a strong aqueous solution of commercial K_2S. The same changes were observed as in (1), but the rise of temperature was not so great, and the liquid became opaque very suddenly when the decomposition of the nitro-glycerin was completed.

3. The ordinary yellow solution of ammonium sulphide used in the laboratory had the same effect as the K_2S. In this case the mixture was evaporated to dryness on the steam-bath, when bubbles of gas were evolved, due to the decomposition of the ammonium nitrite. The pasty mass of sulphur was treated with alcohol, which extracted the glycerin, subsequently recovered by evaporation. Another portion of the mixture of nitro-glycerin with ammonium sulphide was treated with excess of $PbCO_3$ and a little lead acetate, filtered, and the ammonium nitrite detected in the solution. These qualitative results would be expressed by the equation—

$$C_3H_5(NO_3)_3+3NH_4HS=C_3H_5(OH)_3+3NH_4NO_2+S_3,$$

which is similar to that for the action of potassium hydrosulphide upon gun-cotton.

4. Flowers of sulphur and slaked lime were boiled with water, till a bright orange solution was obtained. This was filtered, and some nitro-glycerin poured into it. The reduction took place much more slowly than in the other cases, and more agitation was required, because the nitro-glycerin became coated with sulphur. In a few minutes, the reduction appearing to be complete, the separated sulphur was filtered off: the filtrate was clear, and the sulphur bore hammering without the slightest indication of nitro-glycerin.

This would be the cheapest method of decomposing nitro-glycerin. Perhaps the calcium sulphide of tank-waste, obtainable from the alkali works, might answer the purpose.

King's College, London, April 11, 1883.

ON A HITHERTO UNOBSERVED RESEMBLANCE BETWEEN CARBONIC ACID AND BISULPHIDE OF CARBON.*

By JOHN TYNDALL, F.R.S.

Chemists are ever on the alert to notice analogies and resemblances in the atomic structure of different bodies. They long ago indicated points of resemblance between bisulphide of carbon and carbonic acid. In the case of the latter we have one atom of carbon united to two of oxygen, and in the case of the former one atom of carbon united to two of sulphur. Attempts have been made to push the analogy still further by the discovery of a compound of carbon and sulphur analogous to carbonic oxide, but hitherto, I believe, without success. I have now to note a resemblance of some interest to the physicist, and of a more settled character than any hitherto observed.

When, by means of an electric current, a metal is volatilised and subjected to spectrum analysis, the "reversal" of the bright band of the incandescent vapour is commonly observed. This is known to be due to the absorption of the rays emitted by the vapour by the partially cooled envelope of its own substance which surrounds it. The effect is the same in kind as the absorption by cold carbonic acid of the heat emitted by a carbonic oxide flame. For most sources of radiation carbonic acid is one of the most transparent of gases; for the radiation from the hot carbonic acid produced in the carbonic oxide flame it is the most opaque of all.

Again, for all ordinary sources of radiant heat, bisulphide of carbon, both in the liquid and vaporous form, is one of the most diathermanous bodies ever known. I thought it worth while to try whether a body reputed to be analogous to carbonic acid, and so pervious to most kinds of heat, would show any change of deportment when presented to the radiation from hot carbonic acid. Does the analogy between the two substances extend to the vibrating periods of their atoms? If it does, then the bisulphide, like the carbonic acid, will abandon its usually transparent character, and play the part of an opaque body when presented to the radiation from the carbonic oxide flame. This proved to be the case. Of the radiation from hydrogen, a thin layer of bisulphide transmits 90 per cent, absorbing only 10. For the radiation from carbonic acid, the same layer of bisulphide transmits only 25 per cent, 75 per cent being absorbed. For this source of rays, indeed, the bisulphide transcends, as an absorbent, many substances which, for all other sources, far transcend *it*.

* A Paper read before the Royal Society, April 5, 1883.

CONTRIBUTIONS TO MINERAL CHEMISTRY.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts, Medallist in Chemistry and Botany, &c.

(1.) *Rare Elements in Portuguese Iron Ores.*

These ores, principally brown and red hæmatites, and ferro-manganiferous ores, were found lying close to the surface in the vicinity of Casa Branca, Odemira, South Portugal. They are all rich minerals, containing between 60 and 70 per cent of iron. A company (The Peninsular Metal Company) was formed about three years ago to work these mines. The works erected were near the banks of a river, which flows into the Atlantic Ocean, so there was every prospect of success, and it was successful for a short time; but ultimately the company collapsed for want of capital. Furnaces were erected, and the fuel used in the reduction was "sepa" or charcoal from the "Herica root," coal not being found in the neighbourhood. The iron yielded was of excellent quality. Several samples of these ores were sent to me some time ago, through the kindness of Mr. D. Griffiths and Mr. J. Ireland, Engineer, of Manchester.

Recently I have examined these ores, and have found traces of several rare elements. In one sample of a ferro-manganiferous ore I found a considerable quantity of tungsten. A sample of brown hæmatite (specific gravity 4·102) showed on analysis traces of titanium. Another sample of brown hæmatite contained traces of titanium and selenium. The specific gravities of these ores varied from 3·742 to 6·210.

(2.) *Analysis of a Copper Ore from Nova Scotia, and Determination of its Formula.*

This ore, a sulphide of copper, occurs in deposits in the north part of Nova Scotia. It is found in nodules, which

often contain anthracite bands, and is of a grey colour. On the authority of Dr. Dawson ("Acadian Geology," 2nd edition, 1868), the surrounding formations are of Carboniferous and Silurian ages; and I think it probable that these nodules were formed by the action of water and deposited in these formations, for we find some nodules enclosing bands of anthracite. One of these nodules yielded on analysis the following percentage composition:—

Copper	64·101
Sulphur	25·639
Fe_2O_3 and Al_2O_3	3·891
Sand, &c.	5·790
Lime	0·201
Magnesia	0·137
Manganese	0·221
	99·980

From the above analysis the formula calculated for this ore is Cu_5S_4, or it may be said to be a mixture of one molecule of cuprous sulphide and three molecules of cupric sulphide, with the formula $Cu_2S,(CuS)_3$. It will be seen that this is not quite the composition of the natural sulphide of copper known to mineralogists as covelline, although I am given to understand that covelline exists in the same area. The specific gravity of this ore was found to be 4·392.

(3.) *Analysis of a Dresden Syenite.*

The following is a recent analysis of a syenite from the neighbourhood of Dresden:—

Silica	60·020
Alumina	16·663
Potash	6·504
Soda	2·410
Ferrous oxide	7·207
Magnesia	2·509
Lime	3·585
Water	1·100
Phosphoric acid	trace
	99·998

ON THE GALLO-CYANINES.

By HORACE KŒCHLIN.

By allowing an alcoholic solution of nitroso-dimethyl-aniline hydrochlorate to react in heat upon the tannins, or upon gallic acid, there are obtained violet colouring-matters, verging more or less upon a blue according to the nature of the tannin employed. These colouring-matters, which the author names gallo-cyanines, are manufactured by MM. Durand and Huguenin, their chemist (M. Charles Mayer) having succeeded in rendering their preparation practicable.

The gallo-cyanine obtained from gallic acid is sold as "Violet Solide D. H.," in the form of a paste of minute crystals of a metallic lustre, and containing 10 per cent of the dry product.

The author gives a tabular view of the reactions of three varieties of gallo-cyanine—that from gallic acid, that from catechine, and that from morine or morintannic acid. The first-mentioned gives chiefly blue colours; the second, shades more inclining to a red; and the third, greens.

The best solvents for gallic gallo-cyanine, for its industrial applications, are ammonia, soda, and the acid sulphites. Caustic soda at 38° (Baumé ?), in the proportion of 1-30th by volume; and sodium bisulphite at 41°, in the same proportion. If this proportion of bisulphite is exceeded the gallo-cyanine is decomposed, being transformed into an orange colouring-matter, and a substance which remains undissolved and which falls off in a powder from the dyed or printed goods.

The action of the bisulphite is slow, requiring twenty-four hours of contact. At the end of this time the solution is complete, even with 1-60th.

Gallic gallo-cyanine dyes woollens and silks a violet-blue; for woollens a little potassium chlorate should be used in the dye-beck.

The author has experimented with different metallic oxides for fixing this colour upon cotton in dyeing and printing, and he finds that, like alizarine, it requires double mordants. In printing, chrome alone gives shades which bear soaping well. In dyeing, tin, chrome, cobalt, or nickel may be used; with the other oxides the violet does not stand soaping at a boil.

The following colours give a good result in printing:—

Starch	4 kilos.
Water	2 litres.
Tragacanth water	16 ,,
Violet D. H., which has been disaggregated by maceration for twenty-four hours with 1-32nd part sodium bisulphite	18 ,,
Oil	2 ,,
Calcium acetate, 18°	1½ litre.
Acetic acid	6 litres.
Chromium acetate, at 16°	9 ,,

Or—

Starch	6 kilos.
Calcined starch	6 ,,
Water	10 litres.
Violet D. H.	30 ,,
Acetic acid	5 ,,
Chromium acetate, 20°	10 ,,
Magnesium acetate, 30° per litre of colour	4 ,,
Potassium sulpho-cyanide	25 grms.

Light or diluted colours are thickened with gum. After printing, the pieces are steamed for two or three hours, washed, and soaped.

For dyeing cottons the author prepares them by steeping in—

Water	10 litres.
Tin crystals	1000 grms.
Stannic chloride, hydrated, 55°	½ litre.

Washing the next day, and dyeing in violet which has been prepared with bisulphite. The force of the mordant may be increased by a passage through hot chromium acetate, half a litre per piece.

The process of MM. Blondel and Scheurer may also be used. They print—

Potassium dichromate	800 grms.
Water	4 litres.
Caustic soda, 38°	600 grms.
Sodium hyposulphite	800 ,,
Water	2 litres.
Thick tragacanth water	2 ,,
Magnesium acetate, 30°	½ litre.

The last ingredient is indispensable. Steam for two hours, wash, and dye in the violet D. H.

The following process succeeds well, printing on—

Chrome-alum	2 kilos.
Dissolved in chromium acetate, 16°	1 litre.
Tragacanth	1 ,,
Stannic chloride, hydrous, 60°	½ ,,
Magnesium sulphate	500 grms.

For pale shades this mordant is reduced with tragacanth. It is fixed by a passage through hot sodium carbonate, at 500 grms. per litre, and then dunged in lime-water at 80°, with ½ grm. lime per litre.

When dyeing in gallo-cyanine it is always prudent to ascertain that the flots have not an alkaline reaction, and that they slightly redden litmus-paper.

Self-coloured goods may be worked in an ammoniacal solution of the violet, and then in chromium acetate.

These colours resist light and various reagents better than do alizarine violets. Neither concentrated hydrochloric acid nor caustic soda at 38° B. changes the tone of the violets fixed with chrome. The solidity of the violets offers curious variations according to the preparation of the cloth. If it is prepared with stannate the shades are faster as against chlorine, but they resist light better upon unprepared cloth. The violet obtained with gallic gallo-cyanine is not sufficiently decomposed by chromic acid to produce upon this colour the discharges which are obtained upon vat-blue ground. Yellow or maize discharges may, however, be produced by printing the violet over a chrome-orange design which has been saturated wth bichromate, and then, after cleansing, taking the pieces through lukewarm oxalic acid at 25 grms. per litre.

By adding either berry-liquor or alizarine to the colour, or to the dye-beck, olives and "loutres" are produced. Alizarine, in the proportion of 1-30th, considerably enhances the strength of the colour, without sensibly affecting its tone.

Gallic gallo-cyanine dyes violets with aluminous mordants, and blacks with those of iron. These shades do not bear soap, and become white in a boiling soap-bath. In consequence of this inability to resist soap it is possible to print simultaneously alizarine steam reds and a mordant, to dye in violet, and to soap at a boil. The reds which have taken up a certain quantity of violet, and have become garnets, are thus restored to their primitive shade.

Catechine gallo-cyanine gives, in printing and dyeing, redder shades than gallic gallo-cyanine. It is fixed in the same manner, and dyes violets with alumina and iron, which bear soaping at a boil.

Morine or morintannic gallo-cyanine is green; it is fixed in printing with chromium acetate. It dyes olives with mordants of chrome, tin, alumina, and iron. These olives are exceedingly fast against soap.

Ammonium hydrosulphite easily dissolves and reduces it, thus forming a vat in which goods may be dyed by immersion and subsequent oxidation in the air, precisely as with indigo. In dyeing wool the solution must be heated.—*Moniteur Scientifique.*

THE PLATINUM-WATER PYROMETER.

By J. C. HOADLEY.

The following description of the apparatus used for the determination of high temperatures, up nearly to the melting-point of platinum, is offered in answer to several inquiries on the subject.

The object to be attained is a convenient and reasonably accurate application of the method of mixtures to the determination of temperatures above the range of mercurial thermometers, say 500° F., up to any point not above the melting-point of the most refractory metal available for the purpose, platinum.

A first requisite is a cup or vessel of convenient form, capable of holding a suitable quantity of water, say about two pounds avordupois. Berthelot decidedly prefers a simple can of platinum, very thin, with a light cover of the same metal, to be fastened on by a bayonet hitch. For strictly laboratory work, this may be the best form; but for the hasty manipulation and rough usage of practical boiler testing something more robust, but, if possible, equally sensitive, is required. The vessel I have used is represented in section in the accompanying cut, Fig. 1.

The inner cell, or true containing vessel, is 4·25 inches in diameter, and of the same height on the side, with a bottom in the form of a spherical segment, of 4·25 inches radius. It is formed of sheet brass 0·01 inch thick, nickel-plated and polished outside and inside. The outer case is 8 inches diameter and 8·5 inches deep, of 16-ounce copper, nickel-plated and polished inside, but plain outside. There are two handles on opposite sides, for convenience of rapid manipulation. The top, of the same copper as the sides and bottom, is depressed conically, like a hopper, and wired at its outer edge, forming a lip all around for pouring out of. The central cell is connected with the outer case only by three rings of hard rubber (vulcanite), each 0·25 inch thick, the middle ring completely insulating the cell from its continuation upward, and from the outer case. A narrow flange is turned outward at the upper edge of the cell, and a similar flange is also turned outward at the lower edge of the cylindrical continuation of the walls of the cell upward. Between these two flanges, the middle ring of hard rubber is interposed, and the two parts, the cell and its upward continuation, are clamped together by the upper and lower rings of hard rubber, which embrace the flanges and are held together by screws. The joints between the flanges and the middle ring of hard rubber, which might otherwise leak a little, are made tight with asphaltum varnish.

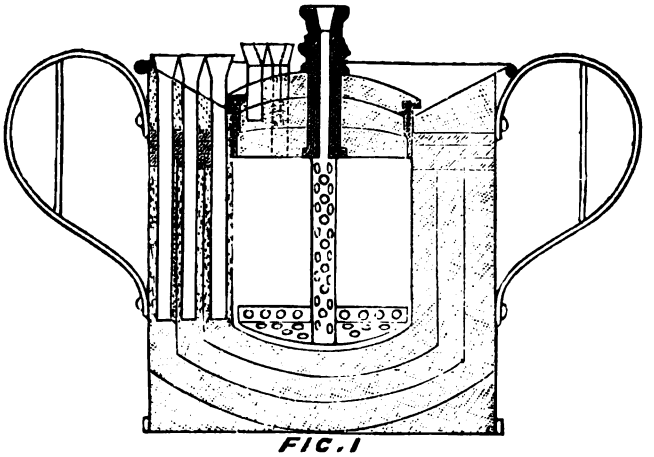

FIG. 1

Fig. 1. shows two partitions, dividing the space between the cell and the case into three compartments, and a con-

cave false bottom. The cover is also seen to be divided into three compartments, by two partitions, and each compartment of the vessel and of its cover is provided with a small tube for inserting a thermometer. This construction was adopted in the first instruments made, for the purpose of observing the rate of heat transmission through the successive compartments, but these parts are without importance with respect to the practical use of the instrument, and may as well be omitted, as they considerably increase the cost, being nickel-plated and polished on both sides. The top and bottom plates of the cover are of 0·01 inch brass, nickel-plated and polished on both sides, both convex outward, the bottom plate but slightly, the top plate to 4·25 inches radius. A ring of hard rubber connects, yet separates and insulates these plates, and they are bound together with the ring into a firm structure by a tube of hard rubber, having a shoulder and knob at the top, and at the lower end a screw-thread engaging with a thin nut soldered to the upper-side of the bottom plate. When the cover is in place, its lower plate is even with the top of the cell; and the contained water, which nearly fills the cell, is surrounded by polished, nickel-plated, brass plates 0·01 inch thick, insulated from other metal by interposed hard rubber. The spaces between the cell and case (a single space if the partitions are omitted), the space above the hard subber rings and the space or spaces in the cover are all filled with eider-down, which costs 1.00 dol. per ounce avordupois, but a few ounces are sufficient. Soft, fine shavings, or turnings of hard rubber are said to be excellent as a substitute for eider-down. Heat cannot be confined by any known method. Its transmission can be in some degree retarded, and in a greater degree, perhaps, regulated. Some heat will be promptly absorbed by the sides, bottom, and cover of the cell, and by the agitator; but this does no harm, as its quantity can be accurately ascertained and allowed for. Some will be gradually transmitted to the eider-down, filling the spaces, and through this to the outer casing; but this can be reduced to a minimum by rapid and skilful manipulation, and its quantity, under normal conditions, can be ascertained approximately, so as not to introduce large errors. But varying external influences, such as currents of air, caused by opening doors, or by persons passing along near the apparatus during the progress of an experiment, which would introduce disturbing irregularities, can best be guarded against by such spaces as I have described, filled with the poorest heat conductor and the lightest *solid* substance attainable. Air, although a poor heat-conductor, and extremely light, is diathermous, and offers no obstruction to the escape of radiant heat.

The agitator is an important part of the apparatus. Its object, in this instrument, is two-fold. *First*, it serves to produce a uniform temperature throughout the body of water in the instrument; and *secondly*, it answers as a support to the heat-carrier of platinum or other metal, often intensely hot, which would injure or destroy the delicate metal of the bottom if allowed to fall on it. For this second purpose, no spiral revolving agitator, such as that commended by Berthelot, would suffice. The best form is such as I have shown in Fig. 1. A concave disc of sheet brass, made to conform to the shape of the bottom of the cell, with a narrow rim turned up all around, of about 0·02 inch thickness, is liberally perforated with holes to lighten it, and to give free passage to water. The concave form causes the streams of water, produced by slightly raising and lowering the agitator, to take a radial direction downward or upward, so as to cross each other and promote rapid mixing. By a slight modification small vanes might be turned outward from the surface of the metal, which would produce mixing currents if the agitator were given a slight reciprocatory revolving motion, thus avoiding the alternate withdrawal and re-immersion of any part of the stem so strongly deprecated by Berthelot; but for several reasons I think an up and down motion of the agitator desirable in this instrument. The platinum heat-carrier, sometimes at a temperature of 2500° to 2800° F., is thereby brought into more rapid and forcible contact with the water, steam or water in the spherical condition is washed away from its surface, and by cooling it more rapidly, the duration of the observation is lessened, and errors due to transmission of heat through the walls of the instrument are diminished. The upper part of the agitator stem is of hard rubber, and the brass portion, which terminates at the under side of the cover when the agitator is in its lowest position, suspended by the shoulder at the upper end, need never be lifted for the purpose of mixing out of the hard rubber tube at the cover, so that loss of heat from this cause must be very slight. The brass tube is very freely perforated with holes to admit water, streaming radially through the holes in the agitator, to contact with the thermometer. The hole in the stem at the top is flared, to receive a cork, through which the thermometer is to be passed. The bulb of the thermometer should be elongated, and very slightly smaller in diameter than the stem. After passing it though the cork, a very slight band—a mere thread—of elastic rubber should be put around the bulb, near its lower end, or a thin, narrow shaving of cork may be wound around and tied on, to keep it from contact with the brass tube, for safety; and a little tuft of wool, curled hair, or hard rubber shavings should be put in the bottom of the brass tube to avoid accidents. For the same purpose, a light, but sufficient fender of brass wire, say 0·03 inch diameter, might be judiciously placed around the brass tube at a little distance, to protect it and the thermometer inside of it from shocks from the platinum ball when hastily thrown in, as it must always be. I have had delicate and costly thermometers broken for want of such a fender. Thermometers cannot be too nice for this work. For accurate work at moderate temperatures, they should be about 14 inches long, having a "safe" bulb at the upper end, with a range of 20° F.—32° to 52°—in a length of 10 inches, giving half an inch to a degree F., and carefully graduated to tenths of a degree, so that they can be read to hundredths, corresponding to single degrees of the heat-carrier in the normal use of the instrument.

For the determination of the highest temperatures, up closely to 2900° F., it will be convenient to have thermometers of greater range, say 32° to 82° F., 50° in a length of 12 5 inches, or a quarter of an inch to a degree F., also graduated to tenths, or at the least, to fifths of a degree. Such thermometers will be about 17 inches long.

It is very satisfactory to have *two* instruments and a good outfit of thermometers and heat-carriers, in order to take duplicate observations for mutual verification and detection of errors.

Heat-Carriers.

For these platinum is greatly to be preferred to any other known substance. Its rather high cost is the only objection to its use. Its heat capacity is low, by weight, but its specific gravity is great, and sufficient capacity can be obtained in moderate bulk, while its high conductivity tends to shorten the duration of each experiment or observation. A convenient outfit for each instrument consists of three balls, hammered to a spherical form, one 1·1385 inches diameter, weighing 4800 grains, = 0·6 pound avordupois: one 0·9945 inch diameter, weighing 2800 grains, = 0·4 pound; and one 0·7894 inch diameter, weighing 1400 grains, = 0·2 pound.

These can be obtained at 1¾ cents per grain, and will cost, respectively, 70.00 dols., 46.67 dols., and 23.33 dols., and collectively, 140.00 dols. At the assumed specific heat of Pt = 0·0333, the heat capacity of the respective balls will be $\frac{1}{10}$, $\frac{1}{15}$, and $\frac{1}{30}$ of two pounds of cold water, and the two smaller balls used together will be equal to the larger one. Corrections for varying specific heat of platinum may be conveniently made by the tables given in a previous article.* Corrections for varying specific

* *Journal of the Franklin Institute* for August, 1882, pp. 97, 98, and errata in *Journal of the Franklin Institute* for September, p. 172.

Temperatures, Fahrenheit, and Corresponding Number of British Thermal Units Contained in Water from Zero Fahrenheit.

Deg.	B.T.U.	Deg.	B.T.U.
32	32·000	82	82·039
33	33·000	83	83·041
34	34·000	84	84·043
35	35·000	85	85·045
36	36·000	86	86·047
37	37·000	87	87·049
38	38·000	88	88·051
39	39·001	89	89·053
40	40·001	90	90·055
41	41·001	91	91·057
42	42·001	92	92·059
43	43·001	93	93·061
44	44·002	94	94·063
45	45·002	95	95·065
46	46·002	96	96·068
47	47·002	97	97·071
48	48·003	98	98·074
49	49·003	99	99·077
50	50·003	100	100·080
51	51·004	101	101·083
52	52·004	102	102·086
53	53·005	103	103·089
54	54·005	104	104·092
55	55·006	105	105·095
56	56·006	106	106·098
57	57·007	107	107·101
58	58·007	108	108·104
59	59·008	109	109·107
60	60·009	110	110·110
61	61·010	111	111·113
62	62·011	112	112·117
63	63·012	113	113·121
64	64·013	114	114·125
65	65·014	115	115·129
66	66·015	116	116·133
67	67·016	117	117·137
68	68·018	118	118·141
69	69·019	119	119·145
70	70·020	120	120·149
71	71·021	121	121·153
72	72·023	122	122·157
73	73·024	123	123·161
74	74·036	124	124·165
75	75·027	125	125·169
76	76·029	126	126·173
77	77·030	127	127·177
78	78·032	128	128·182
79	79·034	129	129·187
80	80·036	130	130·192
81	81·037	131	131·197

heat of water are less important, but may be made by the above Table.

A composite heat-carrier, of iron covered with platinum, answers well for temperatures up to about 1500° F. A ball of wrought-iron 0·88 inch diameter will weigh 700 grains, and a capsule of platinum spun over it 0·048 inch thick, making the outside diameter 0·976 inch, will also weigh 700 grains. Upon the assumption of 0·0333 for the specific heat of Pt and 0·1666 for that of Fe, the composite ball will have a heat capacity equal to that of 4200 grains of Pt, and equal to 0·01 of that of two pounds of cold water. A patch, about 0·35 inch diameter, has to be put in to close the orifice where the Pt capsule is spun together, and a slight stain will show itself at the joint around this patch, from oxidation of the iron, but the latter will be pretty effectually protected. Difference of expansion, which will not exceed 0·007 inch in diameter, will not endanger the capsule of Pt. The interruption of conductivity at the surface contact of the two metals makes the process of heating and cooling a little slower, but not noticeably so.

Such composite balls can be obtained for 20 dols. each, 50 dols. less than the cost of an equivalent ball of solid platinum, which is preferable in all but cost. Iron balls could be used for a few crude determinations. Cast-iron varies too much in composition, and wrought-iron oxidises rapidly. While the oxide adheres it gains in weight, and when scales fall off it loses; and the specific heat of the oxide differs from that of metallic iron. Whatever metal is used, care must be taken to apply the appropriate tabular correction for Pt, Fe, or Pt, and Fe.

Manipulation.

Small graphite crucibles with covers, as shown in section in Fig. 2, serve to guard against losing the ball, to handle it by when hot, and to protect it against loss of heat during transmission from the fire to the pyrometer. To guard against overturning the crucibles, moulded fire-brick should be provided to receive them,—two crucibles being put into one brick, in the same exposure, whenever great accuracy is desired, each serving as a check on the other, and their mean being likely to be more nearly correct than either one if they differ. The fire-brick cover is occasionally useful to retard cooling if, by reason of local obstructions, some little delay is unavoidable in transferring the balls from the fire to the water of the pyrometer. With convenient arrangements this may be done

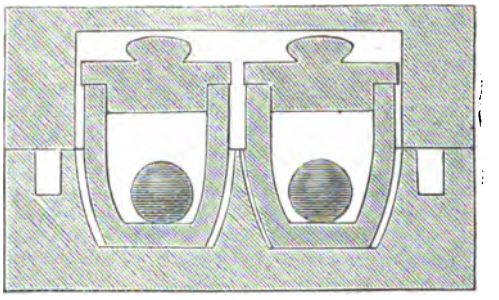

FIG. 2

in three seconds. After observing the temperature of the water, make ready for the immersion of the heat-carrier by raising the agitator until a space of only about 1·5 inch is left between its rim and the cover. An instant before putting in the heat-carrier—"pouring" it in from the crucible—lift the cover and agitator both together, so that the rim of the latter is level with the sloping top of the instrument. The agitator then receives the hot ball without shock, and no harm is done. If the ball goes below the agitator it is likely to injure the bottom of the cup. If, on taking the temperature of the water before the immersion of the heat-carrier, any change is observed, either rising or falling, the direction and rate of such change, and the exact interval of time between the last recorded observation and the immersion should be noted, in order to determine the exact temperature of the water at the instant of immersion. The temperature of the water will continue to rise as long as the heat-carrier gives out heat faster than the cell loses it. The rise will grow gradually slower until it ceases, and the maximum can be very accurately determined. Examples of the mode of using the tables, and of determining the true temperature of the heat-carrier at the instant of immersion from the observations with the instrument, are given in the table on pages 170 and 171 of the *Journal of the Franklin Institute* for September. A method of using the tables by which a closer approximation to the true temperature may be reached will be pointed out in a subsequent article.

Determination of the Calorific Capacity of the Metals of the Pyrometer, in terms of Water, i.e., in British Thermal Units.

First. Weigh the cup, or cell, the lower plate of the cover and the metallic portion of the agitator, and compute their heat-capacity by the specific heat of the respective metals. Compute also the heat-capacity of the thermometer; or, if it be long, of so much of it as is found to share nearly the temperature of the immersed portion. The result will be a minimum,—indeed, in so small a vessel the inevitable loss by conduction and radiation will amount to more than one-third as much as the simple heat-capacity of the metals.* The total must be ascertained by an application of the method of mixture. Ascertain the temperature of the interior of the instrument simply; pour in quickly but carefully a known quantity of water, say about two pounds, of known temperature, say about 100° F., and ascertain the temperature as soon after pouring as mixing can be properly performed. But a correction is necessary for loss of heat in the act of pouring. To ascertain the amount of this correction prepare a bath of tepid water, and bring all parts of the instrument —outside, inside, and interior portions, together with the vessel to pour from—exactly to one common, carefully ascertained temperature. Now take two pounds of the water and pour it into the cell in the same manuer as before. Exposure of so thin a stream on two surfaces to the air of the room will produce a certain degree of refrigeration in the water, which is supposed to be warmer than the air, say at about 160° F. This effect will be due to conduction, by contact with the air, to radiation, and to evaporation; and by so much the refrigeration observed in mixing is to be diminished.

Four experiments, carefully conducted, gave the following results:—

Loss of temperature by pouriny at 170°, 0·81°, 0·86°, 1·00°, and 1·07° F.; mean, 0·935° F.

The following are values of the calorific capacity of my pyrometers, that is, of those parts of each which share directly the temperature of the enclosed water, including the thermometer to be used with the instrument, and the heat communicated to the eider-down and otherwise lost during an observation, expressed in decimals of a British thermal unit, or in decimals of a pound of cold water:—

0·1048, 0·1052, 0·1077, 0·1008, 0·1028, and 0·01104.

Mean..	0·1053 = 0 lb.	1 oz.	11 drms.
Add water ..	1·8947 = 1 ,,	14 ,,	5 ,,
	2·0000 = 2 ,,	0 ,,	0 ,,

This was the value used. The instrument, being put on delicate coin scales and counterbalanced, weights equal to 1·8947 lbs. avordupois = 1 lb. 14 ozs. 5 drms. were added to the counterbalancing weights, and cold water was poured in until the scales again balanced.

The pyrometer with its contained water was then just equal in heat-capacity, while the temperature was not above 38° F. to two pounds of cold water. The two instruments were sensibly alike, but were numbered No. 1 and No. 2, and at each observation the one used was noted.

The process of preparation and testing appears long and tedious, and is indeed somewhat so; but the instruments once well made are durable, convenient in use, and with care reasonably accurate.

Compared with mercurial thermometers between 212° and 600° F., I believe them to be much more accurate, although less convenient.

For a range of temperatures from 212° to 900° F., they are certainly more trustworthy than anything save an air thermometer of suitable construction; and for all temperatures from 800° or 900° F. up nearly to the melting-point of platinum they are without a rival, so far as I know.

For some situations the ball can best be inserted in the fire or other situation where an observation is desired, and withdrawn for immersion by means of long, slender tongs, with jaws resembling bullet-moulds.

A word about the melting-point of platinum. My balls certainly began to melt below 2950° F., but I am by no means sure that they do no not contain any silver, although their specific gravity gives assurance that they are at least nearly pure.—*Journal of the Franklin Institute.*

* In our case the heat-capacity, thermometer included, was 0·0757; total, 0·1053; radiation, &c., 0·0296. Respectively, 71·9 per cent, and 28·1 per cent of the total.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 5, 1883.

Dr. W. H. PERKIN, F.R.S., President in the Chair.

IT was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (April 19). The following certificates were read for the first time:—H. R. Mill, J. E. Richardson, A. H. Samuel R. Williams.

Mr. L. T. WRIGHT then read a paper "*On the Estimation of Hydrogen Sulphide and Carbonic Anhydride in Coal-gas.*" In the analysis of crude coal-gas by absorbtiometric methods—as in Bunsen's, &c.—it is usual to term that portion of the gas which is absorbed by manganic peroxide, ferric oxide, &c., hydrogen sulphide; whilst that portion which is absorbed by caustic potash, and not by manganic peroxide, is usually designated carbonic anhydride. The author first gives some results obtained, by absorption with a bullet of manganese peroxide and with KHO solution, in a Frankland and Ward apparatus: higher results were always obtained when the gases were absorbed successively than when they were absorbed simultaneously by using a solution of KHO. This difference between the results was considerably diminished by submitting the manganese bullet to a current of clean coal-gas before using it for absorption. The author prefers the following method:—The crude coal-gas, dried and freed from ammonia by passing through phosphoric acid, is passed through two weighed U-tubes, the first charged with roughly powdered cupric phosphate in one leg and calcium chloride in the other, the second containing soda-lime (slightly moistened by exposure to the air for about eighteen hours) and calcium chloride. The increase of weight in the first gives the sulphuretted hydrogen, in the second, the carbonic anhydride. The copper phosphate is prepared thus:—2 lbs. of ordinary phosphate of soda are dissolved in 1 gallon of water, and 2½ of cupric sulphate in 1½ gallons of water. The two solutions are vigorously stirred together, the precipitate washed by decantation, and dried at 100° C. Cupric phosphate thus prepared absorbs hydrogen sulphide very perfectly. Before using the absorption-tubes, 3 cubic feet of clean dry coal-gas are passed through to "saturate" the reagents. The gas during the absorption should be passed at the rate of quarter to half a cubic foot per hour. The total quantity must vary with the impurity in the gas. The sum of the hydrogen sulphide and carbonic anhydride thus estimated is always greater than the number obtained by absorbing these gases simultaneously in one U-tube charged with soda-lime. A six inch U-tube charged with cupric phosphate will absorb 20 grains of hydrogen sulphide. A similar sized U-tube charged with soda-lime will absorb perfectly 18 grains of carbonic anhydride.

Dr. ARMSTRONG suggested that some acetylen might be absorbed by the cupric phosphate.

The PRESIDENT asked if bisulphide of carbon vapour was absorbed by soda-lime.

Mr. WRIGHT said that he did not think that the gain of weight was due to absorption of acetylen, and in answer to the President said that bisulphide of carbon was not absorbed by ordinary soda-lime from gas previously freed from hydrogen sulphide.

The SECRETARY then read a paper entitled "*Contribution to the Chemistry of the Cerite Metals*," by B. BRAUNER. In the first part of the paper the author gives an account of a most careful determination of the atomic weight of didymium. The numbers obtained by chemists differ widely from each other, from 142 to 147·39. The author finds that the so-called pure didymium can be split up into heterogeneous constituents. By an elaborate process of purification a sulphate was obtained, which was proved by fractional precipitation with ammonia and with sulphate of potassium to be homogeneous. From this preparation the atomic weight of didymium was found to be 145·4. In a previous paper the author obtained the number 146·58, whilst Clève gave the atomic weight as 147·2. Such discrepancies seemed to indicate the presence of some metal of higher atomic weight and of a less basic nature. This metal the author eventually succeeded in isolating: its formiate is difficultly soluble, and by its absorption-spectrum it was identified with samarium. The author has calculated its atomic weight to be 150. The effect of the presence of samarium on the absorption-spectrum of didymium is carefully studied. The paper concludes with an investigation as to whether cerite contains earths of the yttria group as well as those of the cerium group. By taking advantage of the solubility of the formiates of the yttria group, the author separated out a fraction with atomic weight 114·5, whose spark spectrum showed the presence of yttria, whilst holmia, thullia, and erbia were recognised by their absorption-bands, and the presence of terbia also was suspected.

A communication entitled "*Some Compounds of Antimony and Bismuth containing Two Halogens*, by R. W. ATKINSON, was then read by the SECRETARY. Amongst the so called double salts one of the best characterised is that produced from antimonious chloride and potassic chloride. The author has prepared the compounds obtained by combining antimonious chloride with potassium bromide and antimonious bromide with potassium chloride. On the theory of a molecular combination the first compound should be $SbCl_3+3KBr$, the second $SbBr_3+3KCl$. In both cases the author finds that the compound $Sb_2Cl_6Br_6K_6+3H_2O$ is formed. The identity of the two compounds was proved by identity in colour, crystalline form, formula, and chemical behaviour. The action of heat upon the crystals is of considerable interest. At 100° the lemon yellow substance darkens, and between 200° and 300° white antimonious fumes escape, leaving a white mass behind, which contains chlorine and bromine in equal atomic proportions. Attempts to prepare a similar bismuth compound were unsuccessful, but a yellow crystalline salt, $Bi_2Cl_6Br_4K_4+3H_2O$, was obtained.

Prof. MCLEOD said that it would be of great interest to ascertain the composition of the antimonious fumes given off when the substance was heated.

The Society then adjourned to April 19th.

Determination of Gum in Liquorice Juice.—Madson precipitates the aqueous extract with alcohol at 0·83 sp. gr., and washes with alcohol till all sugar is removed The precipitate is dissolved in a minimum of water, mixed with copper sulphate solution, and precipitated with soda-lye in excess. The precipitate is collected upon a filter, washed with soda solution till the washings run through colourless, dissolved on the filter in dilute hydrochloric acid, the filter rinsed with water, and the arabin thrown down from the solution by the addition of alcohol of sp. gr. 0·83.—*Zeit. für Anal. Chem.*

NOTICES OF BOOKS.

City and Guilds of London Institute for the Advancement of Technical Education. Report to the Governors, March 14, 1883. Gresham College.

WE have here a somewhat voluminous report showing the action and progress of the Institute for the past season. The results are upon the whole satisfactory, and warrant us in entertaining good hopes for the future, especially if certain of the besetting faults of English educational establishments can be avoided.

The Finsbury Technical College is now in fair working order, and in it more than 500 students are already receiving instruction. The South London School has gone on satisfactorily, and we are told that "the number of candidates for the Technological Examinations has steadily increased." Whilst accepting this fact as evidence that the Institute is receiving wider recognition, we cannot refrain from pointing out that a man may possibly acquire a very full and exact verbal knowledge of the principles of an industrial art and still be practically ignorant.

It is satisfactory to learn that a precedent has been established by the late Master of the Rolls for converting apprenticeship-trusts into scholarships tenable at the Technical Colleges of the Institute. The funds of the Institute have been increased, but it is added not to the extent hoped for. The Grocers' Company have continued their subscription of £2000; the Drapers' Company have increased their subscription from £4000 to £4500; the Fishmongers' Company subscribe £2000; the Goldsmiths' £4000; the Clothworkers' £3000; the Mercers' £2000; and a like sum is subscribed by the Corporation of London. Altogether 29 of the City Companies may rank as contributors. Large, however, as these sums are, it is evident that very much larger funds will have to be provided. The Institute has in hand a total of £85,450 to meet present or prospective liabilities of £89,150. In what manner the necessary resources are to be provided it does not clearly appear. It seems almost to be regretted that the money now spent in forcing elementary education upon those who do not desire it had been applied in this direction.

Particular attention is due to a speech delivered by Dr. Siemens, F.R.S., at a meeting held on Dec. 14th last, for the delivery of prizes and certificates. The speaker gave an interesting sketch of the old Guild system, as it existed in Germany down to 1869. It is well known that in modern England the mere fact of having served an apprenticeship is sufficient, in certain trades at least, to place the merest bungler or idler on a level with the clever and competent artisan, whilst, on the other hand, no amount of skill and practical knowledge is recognised, except the form of apprenticeship has been gone through. This was not the case in Germany. Apprenticeship was, indeed, universal, but at its expiry the young man had to undergo an examination, not verbal but practical. He had to produce his "Gessellenstück," literally journeyman's piece of work, which was duly examined by the masters of his trade in the town. If it was found satisfactory he ranked as journeyman, and for the next four years he was expected to travel, obtaining employment under different masters in the towns which he visited, and thus perfecting himself and becoming familiar with different styles and methods of work. At the end of this time he went back to his native city, and if desirous of establishing himself as a master he had to produce his "Meister Stück," or masterpiece. This specimen was examined by a Committee of his Guild, and if approved of, duly exhibited and retained in a local museum. These master-pieces were often real works of art. Dr. Siemens makes mention of the old Trade Museum of Nurenberg, where many splendid specimens of the skill of the blacksmith, the weaver, and the clock-maker, &c., are still preserved. These old Guilds,

we are told, did not seek to fix the rate of wages or the hours of work. Their great object was to exclude from every trade the incompetent and the dishonest. Any master who sold fraudulent articles was, on conviction, expelled from the Guild. Much, of course, of these old regulations is incompatible with the modern organisation of business, but the general principle of a practical examination as a necessary preliminary for every person engaging in any art or manufacture is undoubtedly sound.

Dr. Siemens most justly remarks that "It is not sufficient for after life to be competent to perform the routine work of a craft or calling. Unless you comprehend the scientific principles underlying that calling you may be left high and dry any day, in consequence of an invention which may entirely change the mode of performing the operation upon which you have been engaged."

Of this an instance occurred in the stuff-dyeing trade about 30 to 35 years ago. Up to that time the stuffs dyed in the piece had consisted of pure worsted. When they were first woven with cotton warps, not a few dyers were thrown into a state of perplexity. They knew all the manipulations of their trade, they could dye a piece to the shade required, and they possessed a good stock of receipts for the colours in demand, but they had no knowledge of general principles, and when called upon to encounter cotton warps they felt the ground taken from under their feet.

We note with pleasure that a regular course of study is proposed for each branch of industry with which the Institute concerns itself. The Council quite agree with us in complaining of the "unsystematic and desultory instruction which students too frequently receive in ordinary Science classes."

Reference is made in the report to the Royal Commissioners on Technical Education, who have "continued their inquiry into foreign schools, and whose report may be expected before the close of the present Parliamentary Session. But unless we are completely at fault, investigations of a similar nature have already been made, and reports have already been published. We know that in the facilities for technical education we are inferior, *e.g.*, to Germany and Switzerland, and we know why. Surely, then, it is time for action, instead of inquiry. Commissions are sometimes a convenient method of postponing what public opinion demands.

We were particularly struck with the subjoined passage: "Nowhere in Europe does there exist a system of evening Technical Instruction similar to that which is carried on jointly by the Science and Art Department and the City and Guilds of London Institute through their system of annual examinations and *payment on results*." The words we have italicised denote one of the weak points of English education. We may estimate the "results" of a physician by the cases he cures, of a lawyer by the verdicts he gains, or of a general by the battles he wins. But for the "results" of a teacher we have merely the illusory standard of examinations. Conscientious teachers, of whom we have no lack, complain that they are hampered with a two-fold and a heterogeneous task; on the one hand they wish to give their pupils a thorough knowledge of the subject taught, but on the other they must get them to "pass,"—since on that point payment depends. Unconscientious teachers have an easier task: they simply prepare the pupils for the examinations. The only way to judge of the efficiency of *e.g.* a teacher of chemistry would be to sum up in after years the number of discoveries and inventions effected by his pupils.

If the Institute could be induced to discard this system of payment by sham results it would effect much more for the industrial future of the kingdom than it can otherwise hope to effect.

Determination of Urea by Means of Oxalic Acid.—E. Brücke.—The alcoholic solution of the urea is mixed with a concentrated ethereal solution of oxalic acid.—*Zeit. fur Anal. Chem.*

CORRESPONDENCE.

CHOKE-DAMP.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS (vol. xlvii., p. 159), Dr. Wallace states that *choke-damp* is a "name which in our language is applied exclusively to carbonic acid gas." There can be no doubt that there are many people whose notions of combustion are of the crudest, who talk as if the air were nothing but oxygen, and who regard the miners' choke-damp as nothing but carbonic acid. But surely Dr. Wallace will admit that some people know better; and that they, together with the miners themselves, who are free from the little knowledge that is dangerous, apply the word choke-damp to the mixture of gases that remains in a mine after an explosion —I am, &c.,

H. CHAPMAN JONES.

April 7, 1883.

ACETATE OF LIME.

To the Editor of the Chemical News.

SIR,—I have made a series of experiments with regard to finding a reliable method of estimating the acetic acid in commercial acetate of lime, and find the following gives the best results; the sample is finely ground and about 6 grms. weighed into a half-litre flask, dissolved in water, and diluted to the containing mark. 100 c.c. of this solution are distilled with 70 grms. of strong phosphoric acid nearly to dryness, and 50 c.c. of water are added to the residue in the retort and distilled till the distillate gives no precipitate with nitrate of silver, titrate the distillates with standard caustic soda, evaporate to dryness in a platinum dish, and ignite the residue before the blowpipe, which converts the phosphate of soda (formed by a little phosphoric acid carried over in the distillation) into the insoluble pyrophosphate and the acetate of soda into NaHO; dissolve in water, and titrate with standard H_2SO_4, which gives the amount of soda combined with the acetic acid in the original sample. In a number of samples so analysed they were found to vary hardly anything.—I am, &c.,

C. H. SLAYTOR, F.C.S., London and Berlin.

Regent Square, Doncaster,
April 3, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 12, March 19, 1883.

Observations on Blue Milk.—J. Reiset.—The author mentions that, contrary to the statements of the text-books, freshly-drawn milk has not an alkaline reaction. It reddens blue litmus paper distinctly, the red colour remaining when the paper is dry. On the other hand, it turns red litmus a pale blue, which disappears on the desiccation of the paper. Chevreul alone admits that milk, as it issues from the udder, distinctly reddens litmus.

New Equations relating to the Transport of Power.—Marcel Deprez.—A mathematical paper, not susceptible of useful abstraction.

The Transportation of Power by Batteries of Electric Apparatus.—James Moser.—For the transportation of power on a large scale, the author proposes

to construct enormous accumulators with very large surfaces, and of a very high tension, some at the original source of the power, and others at the place where it is to be employed.

Influence of Tempering on the Electric Resistance of Glass.—G. Foussereau.—Tempering considerably reduces the electric resistance of the different glasses.

A Modification in the Bichromate Battery, rendering it more fit for the Electric Light.—M. Trouvé.—The author remarks that of all the batteries capable of producing the electric light, the bichromate is the only one which can be used advantageously, but it is very inconstant and its action is of very short duration. He overcomes this defect by supersaturating the solution of bichromate.

Combination-heats of the Glycolates.—D. Tommasi.—The author shows that the heats as determined experimentally by M. de Forcrand (*Comptes Rendus*, Feb. 26, 1883), agree with those calculated in accordance with the law of thermic substitution-constants. He gives also a table of the combination-heats of some glycolates, which have not yet been experimentally determined.

Mono-nitro-resorcin.—A. Févre.—The author obtains the sodium salt of this new compound by causing 1 mol. amyl nitrite to act in the cold upon 1 mol. mono-resorcin sodium. The sodium salt of the new compound is then decomposed by sulphuric acid. Free mono-nitroso-resorcin crystallises in gold-coloured needles which are blackened without fusion at 148°; they are very soluble in alcohol and acetone, less so in water, chloroform, and ether, and insoluble in benzol and carbon disulphide. With ferrous salts and iron filings the neutral solution gives a very intense green colour. The author has also obtained an amido-resorcin, a dinitro-resorcin, a dibromo-mono-nitroso-resorcin, and a dinitro-mono-resorcin. Nitroso-resorcin gives coloured reactions with all the phenols. With resorcin and sulphuric acid it forms the diazo-resorufine of Weselsky, which is now manufactured on the large scale at Bâle. The aromatic amines likewise give coloured products with nitroso-resorcin. That obtained by the action of nitroso resorcin upon dimethyl-aniline is of a violet colour, and has much analogy with the product obtained by Meldola from resorcin and nitroso-dimethyl-aniline.

Contributions to the Study of the Plastering of Wine: Rapid Determination of the Cream of Tartar.—P. Pichard.—In a saturated aqueous or alcoholic solution of potassium bitartrate, potassium sulphate and chloride (especially the latter) precipitate the tartrate. Hence, by the addition of potassium chloride to an unplastered wine, the tartar present may be approximately determined.

The Physiological Effects of Coffee.—J. A. Fort.—From a series of experiments the author concludes that coffee acts by exciting the central cerebro-spinal nervous system. In strong doses it produces sleeplessness, cramp, pains in the stomach, and disturbed action of the heart. It neither increases nor lessens the consumption of nitrogenous matter in the system.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 1, 1883.

Detection of Ammonia with Nessler's Test.—Otto Grothe and L. H. Friedburg.—This method does not succeed if the solution in question contains along with ammonia certain quantities of magnesium chloride.

Solubility of Magnesium Carbonate in Water Containing Carbonic Acid.—P. Engel and J. Ville.—From the *Comptes Rendus*.

Determination of Chromium in Chrome Iron.—H. N. Morse and W. C. Day.—6 to 10 grms. potassic hydrate are melted in a wrought-iron crucible (of the shape of an ordinary porcelain crucible and of about 100 c.c. capacity) till the mass flows quietly, and are then allowed to go cold. Upon the surface of the congealed mass about 0·5 grm. of the finely-powdered sample is spread evenly, the potassa melted again, and frequently stirred with an iron rod. In two or three hours the decomposition is complete. The crucible is then laid on its side, and the temperature raised to dark redness. All the chrome is converted into chromic acid in about two to three hours. If the crusts in the crucible retain a green colour this is due to manganese. The cold mass is dissolved in hot water, and the solution heated for some time in order to precipitate any iron which has been dissolved. The filtrate is acidulated with nitric acid, and the alumina precipitated with ammonia. In the filtrate the potassium chromate is reduced, the silica is rendered insoluble by evaporation with hydrochloric acid. In the hydrochloric filtrate there remain merely chromium oxide and magnesia. The author precipitates the former with barium carbonate.

Opening up Chrome Iron.—H. Schwarz.—From *Liebig's Annalen*.

Volumetric Determination of Manganese.—C. G. Särnström proposes the following modification of Guyard's process:—To solutions of manganese he adds so much pure ferric chloride that manganese and iron may be present in approximately equal quantities. During titration the mixture must be stirred diligently, and if much manganese is present the liquid is heated to about 50°. When, on adding the permanganate solution, a red colour is produced which does not disappear, the end of the reaction is reached. The full process is as follows:—1 grm. pulverised manganiferous iron is covered in a beaker with 20 c.c. hydrochloric acid of sp. gr. 1·12, covered with a watch-glass, and boiled for half an hour. The liquid, evaporated down to one-half, is mixed with at least 5 c.c. nitric acid of sp. gr. 1·2, to peroxidise iron and to destroy any organic matter, heated to a boil, evaporated almost to dryness, 5 c.c. hydrochloric acid are added, and the whole boiled as long as orange vapours appear. The liquid is then tested for ferrous salt with potassium ferricyanide, otherwise the treatment must be repeated with 1 c.c. nitric acid. Silica and graphite are not to be filtered off unless they are to be determined or there is danger that the latter may be accompanied by a humoid body. The liquid is evaporated to dryness, the residue dissolved in 5 c.c. hydrochloric acid, heated to a boil, and diluted to about 100 c.c. A saturated solution of sodium bicarbonate is then added in small quantities, stirring diligently until all the iron is thrown down. After the escape of carbonic acid has ceased, the liquid is diluted to 200 c.c., and it is ready for titration.

Titration of Iron with Sodium Hyposulphite.—A. C. Oudemans, Jr.—Reserved for insertion in full.

Solubility of Silver Chloride and Bromide in Water.—J. P. Cooke.—From the Chemical News.

Detection of Mercury.—Biewend mixes the substance with twice its volume of finely-divided metallic copper, introduces the mixture into a test-tube of 15 m.m. in diameter, and introduces close above the mixture a small, brightly-polished, gold plate, rivetted to the end of a piece of steel watch-spring. The latter is bent in a zig-zag shape, so that it may press against the sides of the tube and hold the gold in its place. The tube is held in a slanting position, and cautiously heated from the bottom only, beginning with a moderate flame and raising the heat to incipient redness. The gold plate must not be allowed to become too hot. If the substance examined is bituminous, the plate of gold when taken out must be washed in alcohol before examination.

Volumetric Determination of Phosphoric Acid by Means of Uranium Solution.—K. Broockman and A. E. Haswell.—These authors show that the more uranium solution is used, the higher becomes its relative value.

Thus, according to Broockman, in quantities of 20 c.c., each c.c. represents 0·00498 grm. phosphoric acid; if 36 grms. are used, the value of each c.c. = 0·005125. Haswell confirms the principle, though in quantities of 20 c.c. he finds each c.c. = 0·005000 grm. phosphoric acid.

Spectroscopic Detection of Chlorine and Bromine.—Lecoq de Boisbaudran.—From the *Comptes Rendus.*

Determination of Hydrochloric, Hydrocyanic, Hydroferrocyanic, and Hydrosulphocyanic Acid when Jointly Present.—W. Borchers.—Reserved for insertion in full.

Quantitative Determination of Chloric Acid.—C. Stelling.—The author reduces the alkaline chlorates with a sufficiency of pure ferrous sulphate, supersaturates with potassa-lye free from chlorine, filters, acidulates the filtrate with nitric acid, and determines the chlorine. R. Fresenius points out the necessity of ascertaining in an aliquot part of the filtrate the total conversion of the chlorate into chloride. F. Becker effects the reduction, not in an alkaline, but in a neutral solution, adding potassa only enough to produce a slight precipitate of ferrous hydrate, and boiling for fifteen minutes, which completes the reduction.

Determination of Nitrous Acid along with Nitric Acid by Titration with Permanganate.—If nitrous acid is liberated by adding a stronger acid to the solution of a nitrite, the liquid must be largely diluted to prevent a partial decomposition of the nitrous acid. Lorenz and Kübel show that this method is not accurate if the titration of the permanganate has been effected by means of a ferrous salt or of oxalic acid.

Absorption-spectra of Certain Organic Liquids.—C. H. Wolff.—Hammarsten and Rolbert have shown that traces of thymol may be recognised by the splendid red colour obtained on heating with glacial acetic acid and sulphuric acid. This liquid, according to Wolff, has an absorption-spectrum very similar to that of oxy-hæmoglobine, but with reversed intensity. There is a broad, dark band about Frauenhofer's line E, extending from the wave-length 495 to 560, and a fainter and narrower at D. Wolff confirms the statement of Schack on the absorption-spectrum of the blue liquid obtained by the action of acetic acid upon oil of peppermint. The red colour which, according to Lustgarten, is obtained by the action of an alkaline solution of resorcine upon iodoform, is characterised by a strong absorption-band, almost identical with the darker of the two described under thymol.

Reactions for the Detection of Naphthol, Chloroform, and Iodoform.—S. Lustgarten.—If naphthol is dissolved in strong potassa-lye, a little chloroform or chloral hydrate added, and the mixture gently heated, the liquid, even with very small quantities of naphthol, assumes a transitory blue colour. The reaction can be applied inversely for the detection of small quantities of chloroform. Iodoform, if heated with phenol-potassium or resorcin-potassium, forms rosolic acid, the liquid assuming a red colour, which disappears on the addition of an acid. This reaction serves to recognise substances which, on treatment with iodine and alkali, constitute, or give rise to, iodoform, *e.g.*, ethylic alcohols.

Detection of Malic Acid.—MM. Papasogli and Poli.—On boiling with a few drops of malic acid and a little potassium dichromate, malic acid may be recognised by the smell of fresh apples.

Recognition of Tertiary Alcohols.—C. Hell and Fr. Urech.—The authors use a mixture of carbon disulphide and bromine. On prolonged contact with this mixture the tertiary alcohols form the bromide of the alcohol-radicle, hydrobromic acid and oxygen, which reacts upon the carbon disulphide, so that if the mixture is poured into much water, sulphuric acid is found in quantity. The primary and secondary alcohols do not exhibit this reaction, but, in presence of water and of organic acids, carbon disulphide is oxidised by bromine.

The Behaviour of Gluconic, Saccharic, Lactonic, and Mucic Acids.—H. Kiliani.—The above acids do not reduce the copper solution.

Saccharine.—Léon Cuisinier.—From the *Moniteur Scientifique.*

Colchicine and its Decomposition-Products.—J. Hertel.—This paper, with the accompanying table, does not admit of useful abstraction.

Alkaloids of Quebracho Bark.—O. Hesse.—From *Liebig's Annalen.*

Determination of Carbon and Hydrogen by Combustion in a Current of Oxygen.—M. Etard.—The author places the boat not in direct contact with the glass of the combustion-tube, but upon a trough-shaped piece of platinum foil, perforated with many holes. Instead of granular copper oxide he fills the front part of the tube with fragments of pumice which have been steeped in copper nitrate and ignited.

Combustions with Lead Chromate.—H. Ritthausen.—From the *Journal für Praktische Chemie.*

Determination of Nitrogen in Organic Compounds.—Hubert Grouven.—The author passes over the substance, superheated steam at 400° to 700°, which incinerates it, and converts the nitrogen partly into ammonium carbonate and partly into volatile nitrogenous compounds, which are then fully transformed into ammonium carbonate by passing over an ignited stratum of Grouven's "contact mass,"—a mixture of peat, potters' clay, and "meadow-chalk." The ammonium carbonate is conducted into a recipient containing normal acid, and the excess acid is determined volumetrically. [The author has taken the step—without precedent, we believe, on the Continent—of patenting this process!—*Ed.* C.N.]

Solubility of Sodium Benzoate in Alcohol.—H. Hager.—1 part of benzoic acid, from whatever source, dissolves in 13 parts of alcohol at 90 per cent.

Solubility of Tartar in Water.—C. v. Babo and C. Portele.—The authors give a table of the solubility of tartar in water from 0° to 100°.

Specific Gravity of Aqueous Solutions of Tartar Emetic.—G. Streit has drawn up a table of the specific gravities of potassium antimony tartrate in solutions containing from 0·5 to 6·0 per cent, and at the temperature of 17·5°.

Analysis and Elementary Composition of Starch.—F. Salomon.—From the *Journal f. Praktische Chemie.*

Optical Rotatory Power of Organic Substances.—Under this head are briefly mentioned a number of researches, for which we must refer to the original.

Carbonic Acid in the Atmosphere.—MM. Marié-Davy, A. Muntz, and E. Aubin.—From the *Comptes Rendus.*

Analysis of Wines.—Here are briefly summarised methods for the determination of extract and glycerin, by R. Kayser; for the examination of plastered, "Chaptalised," "Petiotised," and "Gallised" wines, by the same author; for the detection of red colouring-matters, by J. de Groot, P. Pastrovich Lambert, and Ch. Thomas.

Determination of Tartaric Acid.—R. Kayser.—The author recommends the method of Nessler and Barth (*Zeitschrift f. Anal. Chemie*, xxi., p. 61). In opposition to Schmitz and Nessler, Mering maintains the harmlessness of the non-fermentible constituents of potato-sugar as used in artificial wines. Schmitz upholds his former experiments and the conclusions to which they lead.

Examination of Coffee.—C. Krauch has examined the specific gravity of decoctions of coffee and its adulterants, and has come to results closely agreeing with those of Graham, Stenhouse, and Campbell. Skalweit has drawn up a table for determining the sp. gr. of extract of coffee at different degrees of concentration.

Detection of Fusel in Commercial Alcohol.—H. Marquardt.—The author dilutes 150 grms. of the alcohol to be examined with water so as to bring it to from 12 to 15 per cent of actual alcohol. He shakes it up with 50 c.c. chloroform for fifteen minutes, and draws off the chloroform. This process is repeated three times. The chloroform extracts are mixed together, and shaken up three times with an equal volume of water for fifteen minutes, in order to remove alcohol. The chloroform which now contains no alcohol, but all the fusel, is mixed with a solution of 5 grms. potassium bichromate in 30 grms. water and 2 grms. sulphuric acid, and heated for six hours to 85° on the water-bath in a strong, well-corked bottle, shaking frequently. When the oxidation is complete the contents of the flask and the washings are introduced into a distillation-apparatus, and distilled down to 20 c.c. To the residue about 80 c.c. of water are added, and the mixture is again distilled down to 5 c.c. The distillate is mixed with barium carbonate, and digested for about thirty minutes in a reflux cohobator. The chloroform is distilled off, the residue is evaporated on the water-bath down to about 5 c.c., freed from the excess of barium carbonate by filtration, washed, and the filtrate is evaporated to dryness on the water-bath. The residue is dissolved with water and a few drops of nitric acid, so as to make up 100 c.c. In 50 c.c. the barium is determined, and in the other 50 c.c. the chlorine. The quantity of barium chloride corresponding to the chlorine is deducted from the total residue, and from the baryta of the rest the quantity of the fusel is calculated so that 2 mols. amylic alcohol represent 1 mol. baryta.

Determination of Nitrogen in Nitric Ethers.—F. Hess.—This memoir cannot be reproduced without the three accompanying illustrations.

Volumetric Determination of Ferrocyanogen in Crude Potassium Ferrocyanide.—J. Tcherniac.—This memoir is reserved for insertion in full.

Determination of the Cinchona Alkaloids.—Reserved for insertion in full.

Determination of Urea in the Blood.—W. v. Schrœder.—This memoir does not admit of useful abstraction.

Detection of Nitrous Acid in Blood.—G. Bertoni and C. Raimondi.—The authors make use of the principle of dialysis. Nitrites, if present, diffuse into the water outside, whilst the albumenoid matters are retained.

Detection and Separation of Phenols and Aromatic Oxy-acids in Urine.—E. Baumann.—For this important memoir we refer to the *Zeitschrift f. Physiologische Chemie*, vi., p. 183.

Determination of Sugar in Diabetic Urine.—HH. Antweiler and P. Breidenbend.—The authors seek to calculate the quantity of fermented sugar either from the quantity of alcohol formed, or from the decrease of the specific gravity of the fermented liquor.

Detection of Arsenic in Textile Goods, &c.—Emil Lyttkens oxidises the swatch (440 square c.m. of printed goods, wall-papers, &c., or 220 square c.m. of dyed tissues) by treatment with dilute sulphuric acid and potassium chlorate. Any arsenic acid formed is reduced by the addition of sodium sulphite, filtered, and treated with a current of sulphuretted hydrogen. After twelve hours the mixture is filtered again, the precipitate is treated on the filter with a warm solution of ammonium carbonate, and the solution of arsenious sulphide thus obtained, along with small quantities of organic matter, is evaporated to dryness on the water-bath, and treated again with sulphuric acid and potassium chlorate, and the liquid thus obtained is heated till it is free from chlorine and colourless. It is then introduced into a Marsh apparatus, and the reduction-tube is kept ignited for twenty minutes.

Contributions to the Forensic Chemistry of the Vegetable Alkaloids.—These refer to the alkaloids of quebracho bark; to those of the Pereiro bark; and the alkaloids of gelsemium root.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., January, 1883.

Purification of Graphitoid Carbon and the Preparation of Pure Carbon for Electric Lighting.—M. Jacquetain.—The luminous power and the fixity of the Voltaic arc of a pure carbon, obtained either directly or by purification, increases at the same time as its density, its hardness, and its purity. The native graphitoid carbon of Siberia has the property of acquiring by purification a luminous power double that which it presents in the natural state, and surpassing by one-sixth that of pure artificial carbons.

Bulletin de la Société Chimique de Paris.
No. 5, March 5, 1883.

Thermometric Measurements and the Determination of Melting- and Boiling-Points.—J. M. Crafts.—Noticed under *Comptes Rendus*, vol. xci., xciv., and xcv.

A New Ammonium-Cobaltic Compound.—L. Maquenne.—On treating Fremy's oxy-cobaltic sulphate with sulphuric acid diluted with water and alcohol, the author obtains a rose-coloured powder, which, if treated with an excess of chlorine water, is transformed into a green crystalline product, sparingly soluble in water. This compound is a cobaltamine sulphate. It is rapidly decomposed by boiling water and alkalies, but dissolves in dilute acids without immediate decomposition.

Cosmos Les Mondes.
Nos. 10 and 11, March 10 and 17, 1883.

These numbers contain no chemical matter.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Anhydrous Ammonia.—(Reply to T. P.)—Send particulars of requirements to E. G. M., 3, Unity Street, Bristol.

Gas Purification.—Can any of your readers inform me of a good way of purifying common coal-gas. That which I have to use is very impure, the products of combustion being disagreeable and irritating. The amount used is equal to about twenty Bunsen's burners.—R. H.

MEETINGS FOR THE WEEK.

MONDAY, April 16.—Medical, 8.30.
—— Society of Arts, 8. Cantor Lectures. "The Decorative Treatment of Metal in Architecture," by George H. Birch, A.R.I.B.A.
TUESDAY, 17th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
WEDNESDAY, 18th.—Society of Arts, 8. "The Government Patent Bill," by H. Trueman Wood, B.A.
—— Meteorological, 7.
THURSDAY, 19th.—Royal Institution, 3. "Art of Pheidias," by Dr. Waldstein.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
—— Chemical, 8. Ballot for the Election of Fellows. "Note on an Apparatus for Fractional Distillation under Reduced Pressures," by Mr. L. T. Thorne.
FRIDAY, 20th.—Royal Institution, 8. "The Island of Socotra," by Prof. Balfour, at 9.
—— Society of Arts, 8. "The Fisheries of India," by Surgeon-General Francis Day.
SATURDAY, 21st.—Royal Institution, 3. "Geographical Evolution," by Mr. A. Geikie.

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1221.

ON THE ATOMIC WEIGHT OF GLUCINUM (BERYLLIUM).*

By T. S. HUMPIDGE, Ph.D., B.Sc.

In this paper the author shows that no conclusions with respect to the atomic weight of glucinum can be drawn from analogy of its compounds with those of other metals, and that this long-disputed question can only be decided by the specific heat of the metal or by the vapour-density of some of its volatile compounds. Two determinations of the specific heat have been made by Professor E. Reynolds and M. Nilson, the former of whom obtained a result of about 0·6, and the latter only about 0·4. The probable inaccuracies in Professor Reynolds's apparatus are pointed out, and it is shown that his metal was probably very impure.

The author has prepared metallic glucinum from the chloride, the vapour of which was passed over sodium contained in *iron* boats in a glass tube. A metal was thus obtained which had the composition :—

Gl	93·97
Gl_2O_3	4·71
Fe	1·32
Si	traces
	100·00

and was probably the purest yet prepared.

The specific heat was determined by a modification of Regnault's method of mixtures, using electrical appliances to avoid the necessity of an assistant. Three determinations of the specific heat of silver in water, made to test the apparatus, gave the following results :—

I.	0·05677
II.	0·05571
III.	0·05556
Mean ..	0·05601

and with a mean error of only 0·6 per cent. The specific heat of metallic glucinum was determined in turpentine, of which the specific heat was found to be 0·4231, and with the following results :—

I.	0·4326
II.	0·4264
III.	0·4357
Mean ..	0·4316

and with a mean error of 0·9 per cent. Making a correction for the impurities contained in the metal, its true specific heat would be 0·4455, whence if the atomic weight is 13·65, the atomic heat becomes 6·07. This must, therefore, be the true atomic weight, and not two-thirds of this, or 9·1.

The number found by Nilson was somewhat lower than this (0·4079), and the above results may be too high, firstly, from hygroscopic moisture, and secondly, from heat produced when the liquid was absorbed by the porous metal. About 0·67 grm. of the metal was used for the determinations, and it was compressed to a compact disk in a steel mortar.

The author is continuing the research.

* Abstract of a Paper read before the Royal Society, April 12, 1883

ON THE BASIC SULPHATES OF COPPER.

By SPENCER UMFREVILLE PICKERING, B.A. (Oxon.), Lecturer in Chemistry at Bedford College.

Accounts of an investigation on the basic sulphates of two pseudo-triad metals, aluminium and iron, have already appeared in the Chemical News (vol. xlv., p. 121), and in those of the *Journal of the Chemical Society* (1880, p. 807), the general result arrived at being to show that these two metals did not form the large number of basic sulphates which they were supposed to do.

An investigation of the sulphates of a metal belonging to a different class, namely, copper, has since been made, and the results of this investigation, as here detailed, show that this metal forms two instead of six basic sulphates.

The basic precipitates dealt with were analysed either without being dried, as in former cases, or were exposed to the air till they became constant in weight, which they did very soon, the water retained by them being determined by difference.

In some of the earlier experiments the numbers obtained were vitiated to a certain extent by the basic precipitates not having been sufficiently washed before analysis, as it was subsequently found that they required a very prolonged washing, and that it was impossible to ascertain when that washing was complete, owing to the fact that the basic salt itself dissolved in water to a certain extent. Various test analyses showed that the average experimental error amounted to about ±0·2 per cent.

I. *Copper Sulphate Solution Boiled.*

On boiling a neutral solution of copper sulphate a small quantity of a greenish-blue deposit is invariably formed. The formation of this deposit is complete in about ten minutes, and is not due to any of the acid being carried away in the current of steam. In the various experiments made the copper in the precipitates amounted to between 2·5 and 0·37 per cent of the total copper present, the amount precipitated increasing with the dilution of the solution. The following analyses were made :—

Strength of the sol. taken.	20 per cent.	10 per cent.	2·5 per cent.	1·28 per cent.	Various.	Theory for $6CuO,2SO_3,5H_2O$.
CuO	63·323	65·743	65·083	65·289	64·535	65·502
SO_3	23·301	23·378	22·967	22·368	23·258	22·083
H_2O	13·376	10·879	11·950	12·343	12·207	12·415
CuO in the anhydrous substance	73·101	73·768	73·916	74·4	73·508	74·787

These analyses do no not agree very well with the theoretical numbers—the water being rather variable, and the copper oxide percentages being too low,—this, however, is probably due to causes mentioned in the next paragraph; and we may safely conclude that a definite basic salt, namely, $6CuO,2SO_3,5H_2O$ is precipitated in this way.

II. *Precipitation of Copper Sulphate by Potassium Hydrate in the Cold.*

The results of a series of experiments on the addition of pure potassium hydrate to a cold solution of copper sulphate are given in Table I.

It is there seen that when the amount of potassium hydrate added is less than 1·5 molecule to every molecule of the sulphate present the precipitate is light blue in colour and in composition approximates to $4CuO,SO_3$, which contains 79·798 per cent CuO; but that when the

amount of alkali added is greater, the precipitate is bulky and of a dark blue colour, and then, on being kept, washed, or warmed, becomes more or less black, evidently containing uncombined copper hydrate.

The numbers in the third column vary considerably, but in no definite direction, and are all lower than 79·798, but this irregularity and non-concordance with the theoretical numbers is due to the precipitates not having been washed sufficiently, as is shown by the following considerations and experiments.

In the case of those precipitates mentioned in Table I., which approached more nearly in composition to $4CuO,SO_3$, namely, Nos. 7, 10, 11, 12, 14, four of these had been washed two or three times as much as the others.

A precipitate, similar to No. 8, which had been washed with 5½ litres of water, was found on analysis to contain 79·675 per cent CuO.

Another similar precipitate, after being twice boiled with 150 c.c. of water, gave the percentage of CuO as 79·499.

The precipitates obtained by the action of an acetate as described below, appear to be exactly similar to those obtained here, except that they are more easily washed, and they approach more nearly to the composition indicated by the formula $4CuO,SO_3$.

On the whole, there can be little doubt but that the addition of potash to a solution of copper sulphate precipitates a definite basic salt, as long as the proportion of alkali added does not exceed 1·5 molecule for each molecule of copper sulphate present, and that, therefore, the action takes place according to the equation—

$$4CuSO_4+6KOH=4CuO,SO_3+3K_2SO_4+3H_2O.$$

Tetra-basic copper sulphate dissolves in water to a small extent, one litre of cold water taking up about 0·017 grm. of the salt; and this solution, on concentration at a boiling heat, becomes dark, owing to the separation of copper hydrate.

The basic salt was never found to contain any appreciable quantities of potassium sulphate, or of carbonate, provided it had been thoroughly washed; and it was also found to remain quite unaltered in colour, and to absorb no carbon dioxide when exposed to the air for an indefinite period, but when kept in a solution of carbon dioxide an appreciable amount of carbonate was formed in the course of a few days. Protracted immersion in boiling water did not affect it in the least.

III. *Precipitation of Copper Sulphate by Potassium Hydrate while Boiling.*

In order to ascertain the true nature of the precipitate obtained by adding potassium hydrate to a boiling solution of copper sulphate, it was necessary to boil this latter solution for about 15 minutes and filter before adding the alkali, as otherwise some of the basic sulphate, $6CuO,2SO_3$, would have been formed by the boiling itself, and would have vitiated the results. On the addition of the potasium hydrate a black precipitate of copper hydrate is first formed, which soon changes to a greenish-blue solid; the results of various analyses of this substanee are given in Table II., the numbers in which will be seen to correspond pretty well with those for $7CuO,2SO_3,7H_2O$; the CuO percentages, however, are higher than the theoretical numbers, whereas, owing to the difficulty of efficient washing, and owing to the probable contamination with a certain quantity of $6CuO,2SO_3$, the results would be expected to be lower. The analytical numbers, moreover, correspond sufficiently closely with those given in Table I. to warrant the conclusion that the same substance, namely, $4CuO,SO_3$, is obtained in both cases, and that, therefore, the existence of $7CuO,2SO_3$ is more than doubtful.

These analyses, together with others performed on precipitates obtained by the action of potash on cold copper sulphate solution, show that this tetra-basic sulphate, when dried by exposure to air, is combined with $4H_2O$; in one solitary instance, however, the analysis showed the presence of $4\frac{1}{2}H_2O$.

The same basic salt when obtained by the action of an acetate (*vide infra*) was found to retain only $2H_2O$, and this hydrate remained unaltered on being heated in a current of dry air at 100° C.

IV. *Precipitation by Sodium Acetate.*

When a solution of sodium acetate is added to one of copper sulphate, a light blue flocculent precipitate is first formed, which, after a time, becomes granular, and this change in appearance may be much accelerated by the application of heat.

Some experiments on the composition of the precipitates thus produced in the cold are given in Table III. From this table it will be seen that the basic precipitate here obtained is the same in every case, and corresponds within experimental error to $4CuO,SO_3$ (which contains 79·798 per cent CuO), the greater accuracy of the numbers here as compared with those given in Table I. being attributable to the fact that these precipitates are more easily washed than those obtained by potash.

It will also be seen that the amount of precipitate eventually obtained is only slightly increased by a considerable increase in the amount of acetate or water added, but that the precipitation is retarded by an increase in the amount of the former and accelerated by an increase in the amount of the latter.

The reaction here may be represented by the equation—

$$4CuSO_4+6C_2H_3NaO_2+3H_2O=$$
$$=4CuO,SO_3+3Na_2SO_4+6C_2H_4O_2,$$

but is never nearly complete, owing to the solution of some of the basic sulphate in the hydrogen acetate liberated.

When the precipitation is aided by heat, the only alteration effected is an increase in the amount of the precipitate obtained, thus:—

Experiment 8 was repeated at 60° C. After an hour and a half the precipitation at this temperature was complete, when about 30 per cent of the copper present was found to have been precipitated as a basic sulphate containing 79·931 per cent of CuO; the filtrate on being subsequently boiled for twenty minutes gave nearly the same amount of precipitate containing 79·45 per cent of CuO. Again, on repeating experiment 8 at 100° C., a precipitate containing 79·384 per cent of CuO was obtained. Other experiments gave similar results.

In some cases where the precipitate is obtainable only by the protracted boiling of the solution, it is found to be deposited in minute shining crystalline scales.

V. *Copper Sulphate heated.*

About 5 grms. of the normal sulphate were heated gently in a platinum dish with constant stirring, the dish being weighed at intervals of about fifteen minutes. After all the combined water had been expelled, black particles began to make their appearance, and these increased in quantity till the experiment was concluded, when the resulting mass was found to contain 94·3 per cent of CuO, and was evidently nothing but a mixture of insoluble copper oxide and soluble undecomposed sulphate. The loss in weight was continuous throughout, and no indications of any definite basic sulphate being formed in this way could be obtained.

VI. *Dilution of Ammonio-Copper Sulphate.*

A solution of ammonio-copper sulphate was prepared by adding ammonia in slight deficit to a solution of copper sulphate, and filtering; the solution thus obtained was found to contain 0·02615 grm. of CuO per c.c.

When water in various proportions was added to this liquid a precipitate of basic copper sulphate was thrown down, which varied in colour and appearance according to the proportion of water added. With small quantities the precipitate was of a moderately light blue colour and

TABLE I.—PRECIPITATION OF COPPER SULPHATE BY POTASSIUM HYDRATE IN THE COLD.

	Molecules of KOH to each mol. of $CuSO_4$.	Molecules of Water present.	P.c. of Cu precipitated. (That taken = 100).	P.c. of CuO in the Precipitate obtained.	Remarks.
1.	0·156	760	10·8	78·109	Light blue.
2.	0·235	760	16·3	77·877	,,
3.	0·351	300	24·3	77·908	,,
4.	0·466	760	33·9	78·461	,,
5.	0·466	760	—	78·452	,,
6.	0·674	760	46·6	77·023	,,
7.	0·674	300	—	79·156	,,
*8.	0·710	760	—	78·189	,,
*9.	0·710	760	—	78·625	,,
†10.	0·925	760	—	79·224	,,
†11.	0·925	760	—	79·000	,,
12.	0·925	760	69·8	78·709	,,
13.	0·925	300	68·1	78·272	,,
14.	1·400	760	98·1	78·631	,,
15.	1·720	760	—	—	Dark blue; bulky.
16.	1·840	760	—	—	,, ,,
17.	1·940	760	—	—	,, ,,
18.	1·974	760	100·0	99·524	,, ,,
19.	4·000	760	100·0	100·000	,, ,,

* & † Duplicate analyses.

TABLE II.—PRECIPITATION OF COPPER SULPHATE BY POTASSIUM HYDRATE AT 100° C.

	Molecules of KOH to 1 molecule $CuSO_4$.	Strength of the $CuSO_4$ solution.	The Hydrated Precipitate contained			P.c. CuO contained by the Anhydrous Precipitate.
			P.c. CuO.	P.c. SO_3.	P.c. H_2O.	
1.	0·01	2·1	65·593	18·547	15·860	77·957
2.	0·01	2·1	66·687	18·012	15·301	78·734
3.	0·02	0·6	—	—	—	77·915
4.	0·02	0·6	66·027	19·029	14·944	77·449
5.	0·04	1·07	—	—	—	78·712
$7CuO,2SO_3,7H_2O$ contains—			65·944	19·056	15·000	77·360
$4CuO,SO_3,4H_2O$ contains—			67·554	17·081	15·365	79·798

TABLE III.—PRECIPITATION OF COPPER SULPHATE BY SODIUM ACETATE IN THE COLD.

	Molecules of Sodium Acetate to each molecule of Copper Sulphate.	Molecules of Water present.	Percentage of Cu in the Ppt. as compared with the total amount taken.	Percentage of CuO in the Anhydrous Precipitate.	Remarks.
			Filtered after 22 days.		
1.	0·54	800	12·0	79·831	A good deal of ppt. after 2½ hrs.
2.	1·64	800	22·6	79·738	Slightly cloudy after 2½ hrs.
3.	8·22	800	26·0	79·794	Questionably cloudy after 15 hrs.
4.	1·64	200	15·0	79·417	No cloudiness after 15 hrs.
5.	1·64	800	22·6	79·738	Slightly cloudy after 2½ hrs.
6.	1·64	4000	24·0	78·255 (?)	Slightly cloudy at once.
			Filtered after 1 day.		
7.	1·36	1300	13·0	79·614	
8.	2·72	1300	15·0	79·624	

TABLE IV.—DILUTION OF AN AMMONIO-COPPER SULPHATE SOLUTION WITH WATER.

	Molecules of Water added to each atom of Copper.	Copper in the Ppt. (That in the sol. taken = 100).	Percentage of CuO in the Anhydrous Precipitate.	Appearance of the Precipitate.
1.	1700	42·7	91·58	Light blue.
2.	5100	85·5	92·128	Dark blue and bulky.
3.	8500	96·3	92·80	,, ,,
4.	17000	97·0	93·15	,, ,,
5.	1020	—	—	No precipitate after 15 mins.
6.	1360	14·4	88·664	Very light blue, not bulky.
7.	3400	70	91·588	Light blue, rather more bulky.
8.	8500	90	92·351	Dark blue and bulky.
9.	34000	94	93·857	,, ,,
10.	72000	94	94·389	,, ,,

compact, while with larger quantities the precipitate was very dark blue and bulky, similar to copper hydrate at the moment of its precipitation. In no cases did they contain more than minute traces of ammonia.

Two series of experiments on this subject were performed, the results of which are given in Table V. The experiments in the two series are concordant in themselves, but those of one series are not strictly comparable with those of the other series, inasmuch as they were not performed at exactly the same temperature. It will be seen that these precipitates do not consist of any definite chemical compound, but they increase in basicity with an increase in the quantity of water added, while, even with the smallest amount of dilution which suffices for obtaining an appreciable precipitate, this latter is considerably more basic than $4CuO,SO_3$, which contains 79·798 per cent of CuO. The amount of the precipitate obtained increases rapidly at first with an increase in the dilution, but afterwards very slowly.

VII. *Copper-Oxide, Hydrate, and Basic Sulphate treated with Solutions of the Normal Sulphate.*

When any of the precipitates which correspond in composition to $4CuO,SO_3$ are boiled with water for an indefinite time they undergo no blackening nor change in colour, whereas, when those containing a larger percentage of CuO are similarly treated, they become more or less quickly blackened. This reaction, therefore, serves to distinguish the definite sulphate $4CuO,SO_3$ from a substance containing a larger percentage of copper oxide.

A precipitate obtained by the dilution of some ammonio-copper sulphate solution in an experiment similar to 3, Table V., was boiled for 10 minutes with a strong solution of the normal sulphate; it was then found to be changed from a dark bulky substance to a light blue pulverulent one, which, on being tested by boiling with water, remained entirely unchanged, and which, on analysis, yielded results proving it to consist entirely of pure $4CuOSO_3$. On repeating this experiment with cold solutions the basic salt obtained was found to vary in composition between $4CuO,SO_3,4H_2O$, and $6CuO,2SO_3,5H_2O$, consisting, no doubt, of a mixture of these two definite salts.

A precipitate obtained by the addition of a slight excess of potassium hydrate to a solution of copper sulphate was found to be completely converted into $4CuO,SO_3$ by digestion with a cold 10 per cent solution of the normal sulphate for some hours.

A sample of precipitated copper hydrate, which had been dried at 100° C., underwent a similar but slower change on digestion with cold or boiling strong solution of copper sulphate, while with some copper oxide obtained by the ignition of the nitrate no change whatever could be induced.

From the fact that in these experiments a deposit was always observed on the sides of the containing vessel it would appear probable that the change is effected by the solution of the copper hydrate or basic sulphate in normal sulphate and its subsequent deposition as $4CuO,SO_3$.

VIII. *Conclusion.*

From the work detailed above it will be seen that two definite basic sulphates of copper are obtainable:—$6CuO,2SO_3 5H_2O$, by boiling a solution of the normal salt, and $4CuO,SO_3 2H_2O$, by the precipitation of copper sulphate by a deficit of potassium hydrate, by the decomposition of copper sulphate by an acetate, and by the action of a solution of the sulphate on copper hydrate. In addition to which it has been shown that on heating the normal sulphate no definite basic salt can be obtained, and that by the dilution of a solution of ammonio-copper sulphate a basic precipitate of varying composition is thrown down.

The following is a list of the more important papers bearing on this subject:—

THOMSON, *Ann. Phil.*, xvii., 244.
ROUCHER, *Journ. Pharm.* [3], xxxvii., 249.
J. DENHAM SMITH, *Chem. Soc. Mem.*, i., 1843, 221.
FIELD, *Phil. Mag.* [4], xxiv., 123.
VOGEL and REISCHAUER, *N. Jahrb. Pharm.*, xii., 345.
CASSELMANN, *Zeitschr. Anal. Chemie*, iv., 24.
KANE, *Irish Acad. Proc.*, i., 182.
KÜHN, *Schw.*, lx., 343.
PROUST, *Ann. Chim.*, xxxii., 34.
BERZELIUS, *Gilb. Ann.*, xl., 300; *Jahrber.* xi., 176.
GRAHAM, *Ann. Pharm.*, xxix., 29.
BRUNNER, *Pogg. Ann.*, xv., 479.
REINDEL, *Journ. Prak. Chem.*, c., 1.

ON THE

USE OF ROSOLIC ACID AS AN INDICATOR, WITH ADDITIONAL NOTES ON THE USE OF PHENOL-PHTHALEIN & METHYL-ORANGE.*

By ROBERT T. THOMSON.

THE following notes are simply an addition to my former paper on the use of litmus, methyl-orange, phenacetolin, and phenol-phthalein as indicators. The object in view, as I stated before, was to determine the value of each indicator when applied to the estimation of alkalies and free acids, and to ascertain the effect (if any) of the impurities—such as sulphites, sulphides, phosphates, &c.—usually found in commercial hydrates and carbonates of the alkalies. The tests were carried out in precisely the same way as described in the former part of this paper.

(1.) *Delicacy of Rosolic Acid in Absence of Interfering Agents.*—The solution employed contained 2 grammes of rosolic acid per litre, 50 per cent alcohol being the solvent used. To test the delicacy of this indicator, 0·5 c.c. of its solution was added to 100 c.c. of distilled water, and decinormal hydrate of sodium (1 c.c. = 0·0031 gramme Na_2O) dropped in. To effect the complete transformation of the pale yellow to a deep pink colour only 0·1 c.c. of the standard alkali was required. This is equal to 0·01 c.c. of normal alkali, and this figure should be borne in mind for the sake of comparing the delicacy of the rosolic acid in absence of interfering agents with its delicacy in presence of the salts to be examined.

(2.) *Application of Rosolic Acid to the Determination of Available Alkali in Pure Hydrate, Carbonate, and Bicarbonate of Sodium and Potassium.*—It is hardly necessary to give a detailed account of this portion of the subject. Several tests were made with quantities of the hydrate and carbonate of sodium and potassium containing 1·55 grammes of Na_2O and 2·355 grammes of K_2O respectively, with the result that exactly these amounts were obtained in each case, by titration with normal sulphuric acid. The deep pink colour retains its original intensity up to the point at which bicarbonate of sodium is produced, but soon gives place to pale yellow, owing to the action of the liberated carbonic acid. It is therefore necessary to boil the solution thoroughly after each addition of acid to bring back the pink colour, and when this is attended to the end-reaction is extremely delicate, and can be effected by at least one drop (about 0·05 c.c.) of normal acid.

(3.) *Determination of Free Ammonia.*—Several experiments, made in each case with a solution containing 0·85 gramme of ammonia (NH_3), gave identical and accurate results. The pink colour remained undiminished in intensity until 49·8 c.c. of the normal acid had been consumed, but on further addition of acid drop by drop, the pink slowly acquired a yellow tinge, and when 50 c.c. had been added the former was wholly eliminated, leaving only the pale yellow colour; but although this is the case the end-reaction is tolerably distinct. This decrease in delicacy of the rosolic acid is not due to carbonic acid, as the ammonia employed did not contain an appreciable quan-

* A Paper read before the Philosophical Society of Glasgow (Chemical Section), March 19, 1883.

tity of carbonate, but, as I shall show presently, is owing to the action of the salt of ammonium formed. Rosolic acid has been specially recommended as an indicator for ammonia determinations, but it is evident that it has no peculiar value for that purpose, even the much-abused litmus being considerably superior to it.

(4.) *Effect of Sulphate, Chloride, and Nitrate of Sodium, Potassium, and Ammonium.*—The quantities of these salts operated upon were exactly equivalent to 1·55 gramme of soda (Na_2O), 2·355 grammes of potash (K_2O), and 0·85 gramme of ammonia (NH_3) respectively. The presence of these salts of sodium and potassium does not sensibly affect the delicacy of the rosolic acid, but each of the salts of ammonium required 0·2 c.c. of normal hydrate of sodium to develop fully the deep pink colour, as against 0·01 c.c. when tested with distilled water alone.

(5.) *Effect of Sulphite of Sodium.*—The remainder of the experiments were made only on sodium salts, as I did not think it necessary to examine further the potassium and ammonium salts. Two tests were made with 3·15 grammes of normal sulphite of sodium, which contain 1·55 gramme of soda (Na_2O). When titrated in the cold only 0·2 c.c. of normal sulphuric acid was required in both cases to destroy the pink colour, but when boiled 5 and 5·2 c.c. were respectively necessary, the results being in the cold 0·006, and in the hot 0·155 and 0·161 gramme of soda (Na_2O). On cooling the boiled solution and titrating back with normal soda, 4·8 c.c. were required to restore the pink colour. From these results it is evident that normal sulphite of sodium (Na_2SO_3) is practically neutral to rosolic acid in the cold, which it also is, as I showed before, to phenol-phthalein, while to methyl-orange, litmus, and phenacetolin the bisulphite ($NaHSO_3$) is the neutral salt. It is noteworthy that the two last-named indicators give with the sulphite very undecided end-reactions, while the three former give very sharp and well defined end-reactions.

(6.) *Effect of Thiosulphate of Sodium.*—This salt is perfectly neutral to rosolic acid.

(7.) *Effect of Sulphide of Sodium.*—The whole of the sodium in this compound is accurately estimated by standard sulphuric acid, with rosolic acid as indicator. The pink colour retained its original intensity until the sodium hydrogen sulphide (NaHS) was formed, but on further addition of acid gave place to yellow, owing to the action of the liberated sulphuretted hydrogen. On boiling, the pink colour returned, and a very sharp end-reaction was secured. It is only necessary to state that the results agreed substantially with those obtained with methyl-orange and litmus.

(8.) *Effect of Phosphate of Sodium.*—Two tests were made with 1·775 grammes of mono-acid ortho-phosphate of sodium, which contains 0·775 gramme of soda (Na_2O). In one case 12·0 c.c., and in the other 12·2 c.c., of normal acid were necessary to complete the change from deep pink to yellow. As the transformation in colour was gradual the end-reaction was extremely unsatisfactory. The results, however, which give as an average 0·375 gramme soda instead of 0·775 gramme, show that the mono-acid sodium phosphate is strongly alkaline, and the di-acid salt practically neutral, to rosolic acid. It is noteworthy that rosolic acid agrees in this respect with litmus, methyl-orange, and phenacetolin, but differs from phenol-phthalein, which indicates the mono-acid phosphate as the neutral salt; while normal sodium sulphite is neutral to both rosolic acid and phenol-phthalein, but strongly alkaline to litmus, methyl-orange, and phenacetolin.

(9.) *Effect of Silicate of Sodium.*—With rosolic acid as indicator the whole of the soda can be estimated by titration with standard sulphuric acid. This must be done in a boiling solution, as otherwise a good end-reaction is not obtainable. The tests were made side by side with experiments made on the same quantity of silicate of sodium, and using methyl-orange as indicator. The results were identical.

(10.) *Effect of Alumina.*—The solution employed for each experiment contained 0·775 gramme of available soda, and 0·103 gramme of alumina. In one titration 25·2 c.c., and in the other 25·25 c.c., of normal sulphuric acid were consumed, which show 0·781 and 0·782 gramme of soda respectively, instead of 0·775. Rosolic acid thus behaves in much the same way, and gives high results to the same extent, as litmus.

(11.) *Effect of Nitrite of Sodium.*—This salt is quite neutral to rosolic acid.

(12.) *Determination of Soda in Borax.*—Rosolic acid is not well fitted for use in this titration, as the end-reaction is extremely indistinct. A solution containing 1·683 grammes of biborate of sodium ($Na_2B_4O_7$), which is equal to 0·516 gramme of soda, was employed, but after the addition of 13·6 c.c. of normal sulphuric acid, the pink began to assume a yellow tint, and the former colour was not discharged till 16·6 c.c. had been consumed. This latter result gives 0·514 gramme of soda as against 0·516 actually present. I showed before that the best indicator for borax was methyl-orange, which gives a very well-defined end-reaction.

(13.) *Determination of Free Sulphuric, Nitric, Hydrochloric, and Oxalic Acids.*—Rosolic acid is an excellent indicator for use in the determination of these free acids, either by standard hydrate of sodium or potassium, the end-reaction in each case being extremely delicate.

(14.) *Determination of Free Tartaric Acid.*—For this purpose rosolic acid is certainly not so well adapted as phenol-phthalein, but the end-reaction is tolerably distinct, and fairly accurate results are obtainable.

(15.) *Determination of Free Acetic and Citric Acids.*—Rosolic acid is useless as an indicator in the determination of these acids, as, besides the end-reactions being very indefinite, normal acetate of sodium is slightly, and normal citrate of sodium considerably, alkaline to this indicator. In this respect rosolic acid resembles litmus, while the delicacy of phenol-phthalein, and the accuracy of the determinations made with it, are perfect.

It is plainly evident, on taking a survey of the above results, that rosolic acid has no particular superiority over other indicators, unless in some cases the fact of normal sulphite of sodium being neutral to it in cold solutions may be found useful. In nearly every case it behaves like litmus, and has none of the good qualities not possessed by the latter indicator, but which distinguish phenol-phthalein, methyl-orange, and phenacetolin.

Having now concluded the consideration of rosolic acid, I will give a few supplementary notes on the use of phenol-phthalein and methyl-orange as indicators.

(1.) *Determination of Free Citric and Acetic Acids.*—In the former portion of this paper phenol-phthalein was recommended as being the only perfect indicator for this purpose, but it was not mentioned that the titration should be done in the cold. The reason for this is that although the normal citrate and acetate of sodium are quite neutral to phenol-phthalein in the cold, yet when heated they give a slightly alkaline reaction (this is especially the case with the citrate), so that a sensibly high result would be obtained in a hot solution. Of course in the case of acetic acid, a hot solution dare not be used, unless excess of soda is first added, and then titrated back with acid.

(2.) *Phenol-phthalein as an Indicator in the Determination of Free Ammonia.*—This is a very important point to which special attention should be directed, particularly with the view of correcting some misleading statements that have been published respecting this indicator. I pointed out formerly that phenol-phthalein was incapable of showing at what point a solution containing a salt of ammonium was neutral, the reason being that such a salt had the effect of destroying the red colour produced by ammonia, even when the latter was present in considerable proportion. Phenol-phthalein has, however, been directly recommended as an indicator for ammonia by one author

and the mono-acid phosphates of sodium, potassium, and ammonium have been stated by another chemist to be neutral to it. This is true as regards the phosphates of sodium and potassium, but with the ammonium salt no definite neutral point is obtainable, owing to the decolourising effect of the salt itself. The experiments made by these chemists have evidently been confined to potassium and sodium salts, while the behaviour of the ammonium salts have been simply assumed from these results. These facts show how incorrect statements may be made by trusting solely to the analogy between the salts of the alkali metals and ammonium.

(3.) *Valuation of Phosphate of Sodium or Potassium, and Phosphoric Acid.*—In the former portion of this paper I had occasion to describe the behaviour of normal orthophosphate of sodium and potassium when titrated with sulphuric acid, methyl-orange and phenol-phthalein being used respectively as indicators. The neutral point with methyl-orange is reached when the di-acid phosphate (NaH_2PO_4 or KH_2PO_4) is formed, while with phenol-phthalein the neutral salt is the mono-acid phosphate (Na_2HPO_4 or K_2HPO_4). On this definite difference of indication (which represents exactly one-third of the phosphoric acid present), I have ventured to base a process, which gives fairly accurate results, for the valuation of any of the ortho-phosphates of sodium or potassium, or of phosphoric acid. This is certainly a determination that is seldom required, but a rapid process of this description is at least of some interest, and may occasionally be found useful. The method consists in adding to 5 or 10 grammes of the sample, previously dissolved in about 80 c.c. of water, normal sulphuric acid from a burette till the faintly-acid reaction with methyl-orange is obtained, or in the case of phosphoric acid, normal caustic soda, added to the same point. The amount of acid or alkali added need not be measured, as the object is simply to add exactly enough to produce the di-acid phosphate. The mixture is now boiled for a short time to expel carbonic acid if present, then cooled (if the solution is kept hot a low result will be the consequence), a little phenol-phthalein added, and the titration accomplished by normal caustic soda or potash, 1 c.c. of which will represent 0·098 gramme of phosphoric acid (H_3PO_4) or 0·142 gramme of mono-acid sodium phosphate (Na_2HPO_4). Several tests were made of a sample of ordinary phosphate of soda, the results being controlled by two determinations by precipitation with magnesia mixture. The following were the results:—

	By Alkalimetric Method.		By Pptn. as $Mg_2P_2O_7$.
Grammes of Phosphate of Soda tested.	C.c. of Normal NaHO consumed.	Percentage of Na_2HPO_4.	Percentage of Na_2HPO_4.
10	28·1	39·90	40·29
5	14·1	40·04	40·35
5	14·1	40·04	—

The theoretical percentage of dry phosphate of sodium in the crystallised compound is 39·66. It will be readily seen from the nature of the process that the presence of carbonate, sulphate, chloride, nitrate, thiosulphate, or sulphide of sodium or potassium will not influence the accuracy of the results. If sulphite of sodium is present it must first be oxidised to sulphate by the addition of a little peroxide of hydrogen (excess of which does not affect the delicacy of the indicators), as otherwise a high result would be obtained.

It will be observed that I have not noticed the application of phenol-phthalein as an indicator in the determination of caustic alkali in soaps, of free and combined fatty acids in oils and fats, and of resin acids, the reason being that this subject has been fully entered into by various chemists.

In conclusion, I may state that I am examining further the behaviour of phenol phthaleins, methyl-orange, phenacetolin, rosolic acid, litmus, and other indicators with other chemical compounds, having in view the special object of extending their employment, if possible, in the analyses of commercial chemical products.

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PYROLOGICAL NOTES.

By Lieut.-Col. W. A. ROSS, F.G.S., late R.A.

XII. On a New Pyrological Test for Boron Trioxide.

"La détermination quantitative de l'acide borique presente de grandes difficultés." "Dans l'impossibilité d'obtenir un dosage direct, l'acide borique a été calculé d'après la perte." The well-known difficulty of quantitatively determining boron trioxide—of which the above quotations, taken respectively from the "Chimie Analytique" of H. Rosé (1862), which I believe still supersedes the work of Fresenius in France (vol. ii., p. 939), and from Des Cloizeaux's "Manuel de Minéralogie" (vol. i., p. 509), are the German and French expression—appertains in some degree to the pyrological qualitative determination by flame colouration; partly because you can obtain the precise shade of green from other substances, *e.g.*, from new, clean, platinum wire (*vide* my article "On a Green Beam," in *Knowledge* last year), and partly because the reaction is only momentary, and involves the use of reagents not, or little, required for any other purpose.

The so-called "Turner's test," by means of fluor-spar and acid potassium sulphate, was, in reality, devised by Prof. Arfvedson, and not by Dr. Turner, as I shall here show on the principle of "Honour where honour is due," although perhaps not precisely relevant to the subject.

Dr. Thomas Thomson, of Glasgow, says (page 164, "First Principles of Chemistry," 1825)—"I then became acquainted with M. Arfvedson's method of analysing the borates by means of fluor-spar. He mixes the borate to be analysed with a determinate quantity of fluor-spar reduced to the state of a very fine powder, and exposes the mixture with the requisite quantity of sulphuric acid to heat. . . . The boracic acid is disengaged in the state of fluo-boric acid, and the base of the borate remains combined with sulphuric acid." The various editions of Dr. Turner's work on Chemistry may now be purchased from any London old-book stall for a shilling, and a reference to it will show that he never mentions this test at all.

I will now detail the chemical and logical grounds upon which my proposed test is based.

In Plattner's celebrated "Blowpipe Tables," last edition, translated by Prof. Cornwall (1882), under the head of *Titanic Oxide*, we have the following statements:—(1) "With borax on platinum wire in R.F., a saturated glass becomes *enamel blue* by flaming." (2) "With salt of phosphorus on platinum wire in R.F., the glass assumes a fine violet colour on cooling." (3) "With soda in R.F. the glass, when perfectly cold, is greyish white to white." In these three experiments the soda and titanic acid are common to all, or constant quantities; the conditions of reaction are precisely similar in each case; the soda alone is evidently neutral as a colouring constituent; and we are therefore reduced to the two assumptions (*a*) that *boric acid* is the cause of the "*enamel blue*" colour afforded in the case of borax, and (*b*) that phosphoric acid is the cause of the "fine violet colour" in the case of salt of phosphorus.

Having thus far procured data for a plausible assumption or probability that even traces of boric acid would be indicated under certain pyrological conditions, by a *blue colour* when brought into contact with a large proportion of titanic acid before the blowpipe, for I had not only often produced Plattner's "enamel blue" with borax as above related, but had published the fact discovered by myself, that titanic acid affords yellow "fragments" in

pure boric acid, O.P., as a reagent, which *become blue in H.P.* (or R.F., see "Man. Bl. Anal." p. 7), my next step was to procure further confirmatory ground for this probability, or rather hope, before proceeding to practical experiment, as follows:—

I knew that the mineral *Warwickite* is essentially a boro-titanate of magnesium and iron, and it was not therefore without a little flutter of anxiety and hope that I looked in Dana's "System of Mineralogy" (1877) in order to see if such an accomplished analyst as Professor Brush should have produced a blue colour in his pyrological treatment of that mineral. After giving T. Sterry Hunt's analysis, "TiO_2 31·5, MgO 43·5, FeO 8·1, ign. 2·0, with a loss of 14·99 p.c., which Smith and Brush show to be boric acid," Prof. Brush details the ordinary blowpipe reactions, showing "with salt of phosphorus in O.F. . . . a clear bead, colourless on cooling" (no manganese), and adds, "with soda *a slight blue colour*," which he assumes to be due to a trace of manganese so small as to have escaped T. S. Hunt's analysis, and his own test with salt of phosphorus.

I now proceeded with my practical experiment by observing what colour sodium pyrotitanate (made by fusing titanic acid with soda B.B. on aluminium plate) would afford with a bead of "glacial phosphoric acid" coloured violet with titanium dioxide when treated in H.P. on charcoal. The colour was a reddish violet, pretty much the same as the bead. Let us call this reddish violet mass A.

I then dissolved as much powder of *Tourmaline* (from a Freiburg cabinet, and known to contain about 8 per cent of boron trioxide) as I possibly could in another phosphoric acid bead by H.P. on charcoal, so as to volatilise as little as possible of the B_2O_3: we may term this saturated bead B. This done, I fused A and B together on charcoal in H.P., fondly hoping—nay, expecting—to produce at least a pale blue colour, but obtained only a grey opaque mass, which could not, even by its partial parent, be termed in the slightest degree, or by the exercise of any ingenuity,—"blue"! In sheer despair, and with some vague intention of separating constituents afterwards by "the wet way," I poured a few drops of distilled water over the mass in a little Berlin capsule, and left my "lab." in disgust.

Next day, still firm in the conviction that my premises, although for the present resulting in such "a lame and impotent conclusion," were sound and good, I returned to the laboratory, resolved to proceed towards the same end by a different series of experiments, and half sadly, half contemptuously, taking up the capsule containing my little abortion of the previous day, found, as much to my amazement as delight, the whole mass crystallised, *and of a pale, but very decided, blue colour!*

The secret was out. The blue titanium-borate of which I was in search had been (pyrologically) dissolved and concealed in the excess of sodium pyrophosphate, and only required to be "crystallised out" of its *aqueous* solution, to make it appear. That the colour cannot be due to any possible trace of manganese present (which is not detectable by treating the tourmaline powder alone with soda on Al plate O.P.) is proved by two facts—(*a*) The manganese would have shown itself by a blue tint in the *dry* solution by H.P. on charcoal; and (*b*)—This reaction *requires* the addition of water, with an aqueous crystallisation in order to succeed, which is not the case with any manganese pyrological reaction.

Most tourmalines are said to contain on the average from 3 to 9 per cent of boron trioxide.

I have now come to an end of my "Pyrological Notes" for the present, and if they have been so fortunate as to have attracted some of the many readers of the CHEMICAL NEWS to the subject, I can only hope that the latter have not been utterly disappointed by the perusal, but may have been even led—like the chemists Herr Pufahl, of Berlin, Herr Mylius, of Freiberg, and Herr Landauer, of Brunswick,—to try my new methods themselves.

NOTICE ON THE ATOMIC WEIGHTS.

By M. A. BUTLEROW.

THE remarkable observation of M. Schützenberger (*Bulletin de la Soc. Chimique*, xxxvii., p. 3), has decided the author to make the following communication. M. Schützenberger announced that in the analysis of certain hydrocarbons he had obtained figures which on calculation lead to a sum of carbon and of hydrogen distinctly greater than the weight of the substance submitted to combustion. Under other conditions these same bodies had yielded him normal results. The question is how to explain such an anomaly, admitting that there is no source of error in the analyses,—a supposition natural in the works of a chemist as skilful as M. Schützenberger? Evidently we can have recourse only to one of the three following hypotheses:—

1. Either the absolute quantity of the ponderable matter is increased; that something which we call force or energy being transformed into what, for us, is matter. We shall doubtless beware of making so hazardous a supposition in the present case, and I personally reject it, though without finding it in general absolutely impossible.

2. Or the absolute quantity of matter remaining the same, its weight has been augmented in consequence of a temporary increase of the intensity with which the substance in question gravitates towards the earth. Such a supposition, if more admissible than the former, seems to me scarcely probable.

3. Or lastly, it is not the weight of the matter which varies in any manner, but its chemical value undergoes a change. Indeed, if we admit that the atomic weight of carbon may descend temporarily to 11·8 (in place of 12, as generally admitted), all is explained. The capacity of saturation of the carbon having been increased by one-sixtieth, the quantity of carbonic acid formed with the same ponderable quantity of carbon will be greater. Instead of $12+(16\times2)=44$, this acid will be now $11{\cdot}8+(16\times2)=43{\cdot}8$, and we shall have about one-hundredth carbon in excess if setting out from *such* a carbonic acid (molecular weight 43·8) we calculate the weight of the carbon and take, as usual, the molecular weight 44, and the atomic weight of carbon = 12.

Is this last hypothesis admissible? In spite of the classical researches of M. Stas I cannot decide to regard it as utterly inadmissible, and I have even undertaken, with the aid of certain young chemists, a determination of some atomic weights under different conditions. I have taken occasion to explain my views briefly to the Russian Chemical Society (*Bulletin Soc. Chimique de Paris*, xxxvi., p. 303). I have undertaken experiments in order to determine comparatively the atomic weights of white and of red phosphorus. Circumstances and the very nature of these experiments having rendered the progress of these experiments very slow, we have also undertaken another series of a less laborious nature, *i.e.*, the determination of the quantity of mercuric chloride formed at the expense of a known quantity of the metal when it is combined directly with chlorine, allowing the latter to act either without the co-operation of light or with exposure to the light of the sun, or of the magnesium flame. Other influences, *e.g.*, that of the electric effluve, will also be brought into play. In most of these cases we propose to effect the determinations by the direct weight of the product formed. Without seeking to attain the extreme precision which characterises the experiments of M. Stas we hope to arrive at a relative decision as to the degree of constancy of the first decimal of the atomic weights.

Such researches, to me, do not appear devoid of all signification. The classical researches of M. Stas have established the absolute constancy of the atomic weights, of the composition and the chemical proportions of certain bodies, and under certain conditions; but it is not useless to establish this constancy under all imaginable conditions or to show that there exist influences which may cause

the atomic weights and the composition of bodies to vary within certain narrow limits. Whilst admitting the absolute constancy of the composition of chemical compounds M. Stas judged it necessary to study the influence of temperature upon the composition of silver chloride, as also that of temperature and pressure upon the composition of ammonium chloride from different sources. This composition was found constant under the conditions indicated, but that does not forbid the supposition that there may be other cases where such constancy does not exist.

The following considerations suggest doubts as to the absolute constancy of the atomic weights.

According to various precise researches, and especially to the incomparable investigations of M. Stas, we are forced to admit that the atomic weights are not expressed by whole numbers.

Yet, on the other hand, most of these weights approach so closely to whole numbers that it is quite impossible to regard these slight deviations as accidental, or to think that Prout's hypothesis is devoid of any serious foundation. At the same time we see in other cases that the numbers furnished by experiment, and upon which we depend in admitting the existence of the law, and for expressing it in a simple and rigorous form, approach more or less to the numbers required by the law, but without being identical.

Experimental results may ordinarily vary within certain limits, according to the conditions to which the body is submitted at the moment of the experiment. Such, *e.g.*, are the deviations found as regards the law of Boyle and Mariotte. As the gases deviate from this law, sometimes in one direction and sometimes in another, and as the magnitude of these deviations varies with the circumstances, we may admit that for each gas there exist conditions of temperature and pressure in which its accordance with the law is perfect. These conditions would be, so to speak, normal conditions with respect to the law of Boyle-Mariotte, and within their limits the law becomes rigorous and mathematically exact.

I therefore ask if the hypothesis of Prout may not become a truth under certain conditions which we cannot as yet precisely lay down? To raise this question is to deny the absolute constancy of the atomic weights, and I do not think that there is any necessity to admit such constancy. Let us set aside the atomic theory of the physicists as well as the atoms regarded as ultimate particles, absolutely indivisible.

What does the atomic weight of an element signify for the chemist? It represents merely a certain ponderable quantity of matter, the bearer of a determinate quantity of chemical energy. But we know well that for other forms of energy its quantity is far from being determined exclusively by the mass of matter. Quite the contrary, we see the mass remain the same and the quantity of energy increase. Why may not the same principle hold good for chemical energy, though within certain narrow limits?

At first sight it may seem strange to admit the possibility of a variation in the composition of a definite chemical compound. Carbonic acid, for instance, would then not be a compound containing absolutely 32 parts of oxygen to 12 parts of carbon (or rather 31·92 to 11·97); this acid would be a compound of carbon and oxygen in which the relative quantity of the constituents may vary, *e.g.*, in the limits of 12 : 32 to 11·8 : 32.

Would these varieties of carbonic acid still constitute one and the same chemical compound? I believe that they would, up to a certain point. There would, it is true, be no longer absolute unity, but the more general properties which we chiefly study, and especially the chemical properties, would remain the same. The properties of a compound are in fact merely the result of the reciprocal action of the elements which combine and mutually saturate each other. This state of saturation would remain without change in all cases, since the relative quantities of chemical energy acting on the part of each element would remain the same, in spite of any change in the magnitude of the masses conveying this energy.

Such a supposition is perhaps hazardous, but is it entirely devoid of probability?—*Bulletin de la Soc. Chimique de Paris.*

BEHAVIOUR OF AMMONIUM SULPHIDE WITH THE METALS OF THE AMMONIUM SULPHIDE GROUP WHEN PRESENT IN SOLUTION AS DOUBLE PYROPHOSPHATES.

By G. BUCHNER.

If, to the solutions of the salts of manganous and manganic oxides, ferrous and ferric oxide, uranium oxide, nickelous and cobaltous oxides, zinc oxide, alumina and chromium oxide, there is added a solution of sodium pyrophosphate, there is formed a precipitate of insoluble pyrophosphates, which dissolve readily in an excess of sodium pyrophosphate; with the exception of the sparingly soluble chromium pyrophosphate these solutions behave differently with ammonium sulphide.

This reagent precipitates zinc, cobalt, nickel, and iron as sulphides, whilst manganese, uranium, chromium, and aluminium remain in solution. This solution, if heated or allowed to stand for some time, deposits manganese as a double pyrophosphate. On boiling, aluminium and chrome are deposited, whilst uranium remains in solution. —*Archiv. der Pharmacie* and *Chemiker Zeitung.*

DETERMINATION OF CAUSTIC ALKALIES IN PRESENCE OF ALKALINE CARBONATES, AND OF QUICKLIME IN PRESENCE OF CALCIUM CARBONATE.

By G. LUNGE.

The author has examined a method first suggested by Degener. The solution of lime is coloured with phenacetolin, and normal acid is dropped in as long as the yellowness produced by each drop at once gives place to redness. If this change does not occur for a few seconds, the burette is read off, and two more drops of acid are added. If the liquid remains yellow the former reading was correct, but if it becomes red the addition of the acid must be continued until a permanent yellow colouration is established.

The determination of caustic soda is effected directly by titration with acid, using phenacetolin as indicator. As soon as the liquid remains of a faint rose colour all the sodium hydroxide is saturated, and only the carbonate remains. If more acid is added the yellowish red colouration changes suddenly to a golden yellow. At this point the carbonate also is saturated. The process is most suitable for caustic lyes which contain moderately large proportions of carbonate. Ammonia behaves differently from caustic soda, and is at once reddened by phenacetolin.

Dr. Lunge recommends practice with this indicator with liquids of known composition, so as to acquire a knowledge of the correct shade of colour.—*Zeitschrift Ver. Rubenz. Ind.* and *Chemiker Zeitung, Cœthen.*

Production of Bromised Apatites and Wagnerites. —A. Ditte.—The apatites and wagnerites form a numerous series of compounds, such that to each term of the series containing chlorine there corresponds another, the composition and general properties of which are the same, but containing bromine.—*Comptes Rendus.*

NOTICES OF BOOKS.

An Introduction to the Study of Organic Chemistry. By Adolph Pinner, Ph.D., Professor of Chemistry in the University of Berlin. Translated and Revised from the Fifth German Edition by Peter T. Austen, Ph.D., F.C.S., Professor of Analytical and Applied Chemistry in Rutger's College and the New Jersey State Scientific School. New York: John Wiley and Son. London: Trübner and Co. 1883.

The multiplicity of books on chemistry that have appeared during the last few years, both original and translations, would seem to afford the most fastidious student of the science a superabundant field from which to select his mental pabulum; still, in spite of all the contributions to chemical literature in the way of text-books, creditable and otherwise, we have here another addition to the stock treating of the carbon compounds.

This work, an American translation, coming as it does from the home of organic research, raised our expectations of getting something really good, especially as the translator tells us in his preface that it "is founded on the system of teaching developed by the distinguished chemist Prof. A. W. Hofmann, of Berlin, and in some cases follows his lectures quite closely." And, again,—"In translating Prof. Pinner's book, I have preserved as far as possible the easy lecture style which is characteristic of it, and have not hesitated to employ numerous expressions which have come into use in working laboratories, and which recommend themselves for brevity and clearness." An examination of the arrangement of the contents, however, did not fulfil the expectations we had formed of the book. That the fault lies in the classification that has been adopted is evident, as it has involved the indiscriminate heaping together of formulæ innumerable, with little, if any, attempt being made to bring out the symmetrical beauties that prevail in organic chemistry.

After a short introduction, in which the tetra-valency of carbon is explained, and the possibility of isomers due to alteration in the radicles and change of position, the author begins with the methane compounds, the halogen, nitrogen, and other substitution-products being described, and what seems greatly out of place in an elementary text-book, the compound ureas, and the phosphorus, arsenic, and antimony derivatives. In this way the work proceeds until hexane is reached. The aromatic compounds are treated in a somewhat similar manner, commencing with a short account of the benzene nucleus, and an explanation of the ortho, meta, and para positions. The last portions of the book are devoted to the alkaloids, glucosides, bitter principles, biliary and protein substances; and as an appendix, the quantitative methods for the ultimate analysis of organic compounds are given, also a clear, but too short, outline of the methods employed for determining the constitution of organic bodies. This latter, we think, might have been extended with profit.

Some of the terms that are introduced do not seem to us to be improvements, as, for instance, "esters" for the compound ethers, methylic formate being termed formic methyl ester, and the word "rest" where radicle might do. The language employed in some parts of the book would require a little preliminary explanation to help the understanding. For example—"It is not remarkable, therefore, that in the group CH_3 an unsatisfied bond, or valence, is free and active, and can only be rendered inactive by an equal y great energy. It makes no difference if this energy is the entire attractive power of a single atom of a mono-valent element, or the remainder of all the active attractive energies of an atomic group so long as its amount is equal to one."—(Page 8.) Again, in the account of certain reactions the language is frequently very lax, as ammonic formate by rapid heating "falls into cyanhydric acid and water," and methylic iodide acts on phosphonium iodide, hydriodic acid being "split off;" also, "Ethylene in the presence of platinum-black unites with hydrogen to ethane;" and, for the sake of brevity we presume, the student is taught that three H's combine with one N, and so on.

The preface says that "The intention has been to make this book not a dictionary of compounds—but a text-book which can be placed in the hands of college students." From our perusal of the work, however, formulæ seem to monopolise the greater part of it, and the reasonings by which the constitution of many important compounds is evolved, left as a puzzle to the enquiring mind. This, we think, might well replace much of the needless symbolism so frequently pressed into works on organic chemistry, and might act as savouring to such dry bones.

"It is believed that a student who has carefully studied and faithfully recited this book will be able to take up understandingly the larger works," and, we might add, even make some little progress in empiric research, but we fear that the student's appreciation of the order and symmetry existing in organic chemistry will not be benefitted to any great extent.

The Gas Manager's Handbook. By Thomas Newbigging, M. Inst. C.E. Third Edition. London: Walter King. 1883.

The information contained in this little book, which is of a thoroughly practical kind, is eminently suited for the use of managers and engineers actively engaged in the gas-lighting industry. The contents are arranged in brief paragraph form, as being the most convenient for reference, and no pains seem to have been spared in culling from all sources innumerable facts and tables that may be of practical service.

Commencing with lengthy tables containing the analytical results obtained from the chief coals employed for gas-making purposes, their yield of coke and gas, and the illuminating powers of the latter, the author passes to retorts, condensers, scrubbers, and other appurtenances that form the plant of a gas-works, giving the dimensions and modes of arrangement found in general use. The purification of coal-gas is pretty fully described, and the methods adopted for the estimation of the several deleterious constituents, but we think that the explanation given of Harcourt's test for carbon disulphide and sulphuretted hydrogen might be made more intelligible, even at the expense of a little theory, and the sketch showing the arrangement of the apparatus lettered.

The corrections to be applied for variations in pressure and temperature, meters, and the plans adopted for computing the illuminating power of coal-gas, are described at some length, a few numerical examples being introduced to show the application of the rules laid down.

In the table of elementary bodies we notice beryllium with an atomic weight of 9·4 and glucinum 9·3, thus giving to the same element two different values; also that the formulæ attached to several of the compounds formed by the destructive distillation of coal are not in harmony with the atomic weights given, as C_2N for cyanogen, and NO_5 for nitric acid. It is a pity also that the only example we notice of the application of atomic weights and formulæ to the calculation of the constituents of a compound is wrong owing to the author taking 6 for the equivalent of carbon in C_2H_4, so that "12 grains, or 12 ozs., or 12 lbs. of carbon combine with 4 grains, or 4 ozs., or 4 lbs. of hydrogen to form 16 grains, or 16 ozs., or 16 lbs. of olefiant gas."—(Page 296.)

It is to be regretted that a little space has not been given to the chemistry of destructive distillation; even the merest outline would be of service to the most thoroughly practical manager, and would form a fair substitute for the tables of "squares" and "cubes" appended to the work. In spite of the few errors we have noticed in this handbook, we feel assured that it will be of no little service to gas-engineers, managers, and others engaged in the manufacture and distribution of coal-gas.

Englisches Conversations-Buch für Pharmaceuten. (English Conversation-Book for Pharmaceutists.) By Dr. Th. D. Barry. Berlin: Julius Springer. 1883.

It is evidently a misnomer to entitle this little work a conversation-book, as of the fifty pages of which it consists only five are devoted to dialogues. This, however, does not detract from its value, as the arrangement and nature of the contents, which consist of vocabularies of pharmaceutical words and phrases, are in a more suitable form than if thrown into dialogues. The book is divided into eleven sections, the first six of which contain words and phrases in daily use among pharmaceutists, the English and German synomyms being arranged in each language alphabetically under various headings, such as drugs, instruments and apparatus, anatomy and diseases. The seventh section gives the German equivalents of the Latin contractions which are employed to adorn prescriptions. The eighth and ninth show the relations of the weights and measures of the British Pharmacopœia to those of the decimal system, gramme, and litre, whilst the tenth section contains a few specimens of short letters.

To the English pharmaceutist having any dealings with German patients we have no doubt that this little work of Dr. Barry's will be found of some service, supplemented with a little colloquial knowledge, especially as many of the phrases are not usually found in ordinary dictionaries.

PROCEEDINGS OF SOCIETIES.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

Ordinary General Meeting, Thursday, April 12, 1883.

Mr. Willoughby Smith, President, in the Chair.

An elaborate paper on "*Microphonic Contacts*," by Shelford Bidwell, was first read, after which a "*Note on the Influence of Surface-condensed Gas upon the Action of the Microphone*, by I. Probert and Alfred W. Soward, was read by the Secretary. The authors have studied the influence upon the action of the microphone of the layer of condensed gas with which the carbon surfaces are coated. In the case of two gases condensable without liquefaction, the better microphonic effect was obtained with the less condensable gas; in the case of two condensable with liquefaction, the better effect was obtained with the gas which in the liquid state is the better electrical conductor.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

March 19, 1883.

Mr. Robert R. Tatlock, F.C.S., President, in the Chair.

The usual preliminary business having been disposed of,

Dr. Clark read a paper "*On a Volumetric Process for the Estimation of Nickel and Cobalt.*"

Mr. Robert T. Thomson read a paper "*On the Use of Rosolic Acid as an Indicator.*" (See p. 184.)

Researches on the Crystalline Phosphates.—MM. Hautefeuille and Margottet.—The authors have obtained a number of phosphates in crystals by using as solvents certain salts in igneous fusion. They dissolve the amorphous phosphates obtained by precipitation in about 4 parts of melted metaphosphoric acid.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. xcvi., No. 13, March 26, 1883.

Note on the Preparation of Cerium Oxide.—H. Debray.

Observation on the Figures given for the Consumption of Zinc by M. G. Trouvé for his Bichromate Battery.—The author points out that the consumption of zinc given by M. Trouvé in his recent memoir is *less* than what would be required by theory. It is therefore desirable that his experiments should be repeated.

Formation-heat of the Glycolates.—M. de Forcrand.—It is not difficult to predict approximately the combination-heat of any acid with a given base in a state of solution. It is sufficient to be guided by a law well known in science, according to which all acids when combining with one and the same base disengage the same quantity of heat. Hence the difference of the neutralisation-heats for two bases or oxides is almost constant. Such is the law of Andrews, which dates back to 1842. If we add to the neutralisation-heat the oxidation-heat of the metal, we have the table of modules of Favre and Silbermann, which is more than thirty years old.

Action of Sulphur upon Oxides.—MM. E. Filhol and Senderens.—A thermo-chemical paper, in which the authors study the action of sulphur upon potassa and soda, both in the solid state and in solutions more or less dilute.

The Action of Different Varieties of Silica upon Lime Water.—E. Landrin.—The author has examined comparatively four varieties of silica: hydraulic silica, gelatinous silica, Graham's soluble silica, and the silica of hydro-fluosilicic acid. He concludes that hydraulic silica, gelatinous silica, and soluble silica absorb lime water more or less rapidly, but that in all cases the absorption varies finally between the limits 36 and 38 per equiv. of silica.

The Type-Hydrate of Neutral Aluminium Sulphate.—P. Margueritte-Delacharlonny.—According to the author the typical hydrate contains not 18 but 16 mols. water; that it does not attract moisture from the air, but rather tends to effloresce, and that it may be obtained in definite crystals, *i.e.*, ortho-rhombic prisms much flattened.

Effects Produced by Air upon Beer Yeast.—D. Cochin.—The air appears to attenuate the ferments as it does the virus of zymotic diseases.

Determination of the Extractive Matters and of the Reducing-power of Urine.—MM. Etard and C. Richet.—The authors remark that in ordinary analyses of urine the urea alone is determined, though it forms only 75 per cent of the organic matter present. For the determination of the other matters they have devised a process based upon the action of bromine upon urine in acid and in alkaline solutions respectively. In an acid solution bromine attacks neither urea, creatine, creatinine, hippuric acid, nor xanthine, but merely uric acid and the so-called extractive matters. In an alkaline solution it acts upon all the above-mentioned substances. The authors promise to give the details of their process on a future occasion.

Cosmos Les Mondes.
No. 12, March 24, 1883.

Combination-Heats of the Soluble Compounds of Strontium.—Dr. D. Tommasi.—The author shows in parallel columns the combination-heats of the soluble

compounds of strontium, as found experimentally, and as calculated in accordance with the law of thermic substitution-compounds, the correspondence being very close.

Journal de Pharmacie et de Chimie.
Tome v., April, 1883.

Contributions to the History of the Reactions between Sulphur, Carbon, their Oxides and their Salts.—M. Berthelot.—Already noticed.

Plumbiferous Tinning of Preserved Meats.—P. Carles.—When tinned iron serves for containing alimentary matters it is essential that the tin employed should be free from lead. The latter metal is rapidly oxidised on the surface and is dissolved in this form in the neutral acids of vegetables, meat, &c. The most exact method of demonstrating the presence of lead consists in treating the alloy—so-called tin—with *aqua regia* containing relatively little nitric acid. The whole dissolves; the excess of acid is driven off by evaporation at a boiling heat, and the residue, diluted with water, is saturated with hydrogen sulphide. The iron remains in solution, whilst the mixed lead and tin sulphides precipitated are allowed to digest for a long time in an alkaline sulphide. The tin sulphide only dissolves; it is filtered off and converted into stannic acid, whilst the lead sulphide is transformed into sulphate and weighed as such.

Toxicological Search for Blood.—C. Husson.—The author describes a case where certain stains on the blouse of a man suspected of murder were proved by the size of the globules to be due to the blood of a rabbit. Certain stains on his shirt which had seemed suspicious had been derived from the dye of his clothing modified by the action of rain and sweat.

Effects of the Respiration of Air charged with Vapours of Petroleum.—M. Poincaré.—The author has kept dogs, rabbits, and guinea pigs in atmospheres resembling those to which persons working with petroleum are exposed. The guinea pigs alone succumbed after remaining from one to two years in this medium. The other animals seemed to resist indefinitely. He nevertheless recommends persons employing petroleum as a source of heat and light or who treat it industrially to keep their stock in closed vessels, to attend to ventilation, and to execute the operations of rectification, &c., under draught-hoods.

Note on the Assay of Quinine Sulphate.—H. Byasson.—The author recommends a polarimetric process, based on the fact that for a neutral quinine sulphate the deviation is $-23{\cdot}3°$; for the cinchonidine salt, $-16{\cdot}5°$; for quinidine, $+26{\cdot}4°$; and for cinchonine sulphate, $+22{\cdot}2°$. The process of Kerner he considers unsatisfactory, as it may cause samples of quinine sulphate containing mannite, gum, salicine, calcium phosphate to be pronounced good.

Memoir on Sprouted Wheats.—M. Ballard.—Not adapted for useful abstraction.

Physiological Action of Sodium Borate: Its Elimination by Saliva and Urine; its Action in Medicine and Odontology; its Pharmaceutical Preparations.—F. Vigier.—The title of this memoir will be a sufficient notice.

Poisonous Properties of the Morel (*Morchella esculenta*).—M. Ponfick.—The author has discovered in these fungi a very energetic poisonous principle, and shows that their safety or danger depends on the method of preparation. The poisonous matter is eliminated by repeated treatments with boiling water, or may be destroyed by prolonged desiccation. The poisonous compound, probably an alkaloid, acts by disorganising the blood-globules.

Action of Carbonic Oxide upon Plants.—L. Just.—The author finds that carbon monoxide is not assimilated by plants, and that in proportions exceeding 1-20th per cent it is injurious.

MISCELLANEOUS.

London Chamber of Commerce: Chemical Trades Section.—The following circular has recently been sent out in view of the formation of a Chemical Trade Section of the Chamber:—"It is proposed to form a chemical section of the London Chamber of Commerce. This would tend greatly to strengthen the hands of all engaged in the various branches of chemical industry in London, giving them more power to influence legislation in favour of their own interests, and enabling them to take a united stand against any action, either individual or corporate, which they consider inimical, as well as adjusting any points of difference which may exist between the various branches themselves. The absence of any joint association of this kind has been most detrimental to us, each and all, in the past, as you will doubtless admit. Now, by means of such a special Chemical Trades Section as I suggest, we shall be not only able to discuss our requirements, but to enlist in favour of our decisions and resolutions the influence and powers of legislative action possessed by the London Chamber. The action of the Chamber in the general interests of the commerce of London is too diffuse and well known to particularise in this letter, but in such matters as the establishment of Courts of Arbitration, under proper laws and control, the alteration of the existing Bankruptcy Act, &c., it will, I am sure, elicit your approval. I have been requested by the Council (of which I am a nominated member) to aid in this project, which, together with the great importance of the subject, I plead as my excuse for thus troubling you. Will you then aid this endeavour by becoming an annual subscriber to, and member of, the London Chamber (subscription £1 1s. as individual, or £2 2s. as a firm), and also help in the formation of the section with your advice, &c. If you are willing to join, kindly fill in the accompanying form, and return it to the Secretary of the Chamber at the above address, and I will see that it is put before the Council immediately, with a view to your election.—T. Farmer Hall."

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Gas Purification.—(Reply to R. H.)—Dr. Versmann took out a patent for purification of gas by means of a preparation of tungsten. This is very effective, and can be used economically in the laboratory. On the small scale the gas is passed through a heated tube containing asbestos that has been treated with tungsten or platinum; a low red heat is sufficient to decompose the CS_2, the resulting H_2S can be removed in the ordinary way. The illuminating power of the gas is improved.—Leo Taylor, F.C.S.

MEETINGS FOR THE WEEK.

Monday, April 23.—Medical, 8.30.
Tuesday, 24th.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
Wednesday, 25th.—Society of Arts, 8.
—— Geological, 8.
—— London Institution, 12. (Anniversary).
Thursday, 26th.—Royal Institution, 3. "Art of Pheidias," by Dr. Waldstein.
—— Royal, 4.30.
Friday, 27th.—Royal Institution, 8. "Solar Physics," by Mr. C. W. Siemens, at 9.
—— Quekett Club, 8.
Saturday, 28th.—Royal Institution, 3, "Geographical Evolution," by Mr. A. Geikie.
—— Physical, 3. "A New Photometer," by Sir John Conroy. "Colour Sensations," by H. R. Droop. "Causes and Consequences of Glacier Motion," by Walter R. Browne. "Measurement of Radiant Energy," by Capt. Abney, F.R.S.

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1222.

ON THE LIQUEFACTION OF OXYGEN AND NITROGEN, AND THE SOLIDIFICATION OF SULPHIDE OF CARBON AND ALCOHOL.*

By S. WROBLEWSKI and K. OLSZEWSKI.

THE following despatch was addressed in the first place by M. Wroblewski to M. Debray on April 9.

"Oxygen liquefied; completely liquid; colourless, like carbonic acid. You will receive a note in a few days."

The note M. Debray has since received, and it reads as follows:—

"The beautiful investigations of MM. Cailletet and Raoul Pictet on the liquefaction of gases permitted the hope that some day chemists would be able to observe oxygen reduced to the liquid state in glass tubes, as is done at present in the case of carbonic acid; the condition being solely to obtain a sufficiently low temperature. M. Cailletet, in a note published a year ago,† recommended liquefied ethylene as a means for obtaining very intense cold. This liquid *under the pressure of one atmosphere*, boils at −105° C. if a sulphide of carbon thermometer is employed to measure the temperature. Having compressed oxygen in a capillary tube and cooled in this liquid to −105° C., M. Cailletet observed at the moment the pressure was released, 'a tumultuous ebullition, persisting for an appreciable time and resembling the projection of a liqid in the cooled part of the tube. This ebullition forms at a certain distance from the bottom of the tube. I have not been able to recognise,' adds M. Cailletet, 'if this liquid pre-exists, or if it is formed on releasing the pressure, for I have not yet been able to see the plane of separation between the gas and the liquid.'

"Profiting by a new apparatus constructed by one of us (Wroblewski), which allows the placing of relatively large quantities of gas under pressures of some hundred atmospheres, we proposed to ourselves to study the temperature of gases during the detent. These experiments have soon led us to the discovery of a temperature at which sulphide of carbon and alcohol freeze, and at which oxygen liquefies completely with great facility. This temperature is obtained by allowing ethylene to boil in a vacuum. The temperature depending on the degree of the vacuum obtained, the minimum we have been able to obtain till now is −136° C. We have determined this temperature, like all the others, with a hydrogen thermometer.

"The critical temperature of oxygen is lower than that at which ethylene boils under atmospheric pressure. This latter is not −105° C., as has been admitted till the present time, but it lies between −102° and 103° C., as we have found with our thermometers.

"From a series of experiments which we have made on April 9, we give the following numbers as an example:—

Temperature.	Pressure in Atmospheres under which Oxygen commenced to Liquefy.
131·6	26·5
133·4	24·8
135·8	22·5

"In publishing these numbers we reserve for our next note the communication of definite values.

"Liquid oxygen is colourless and transparent, like carbonic acid. It is very mobile, and forms a sharp meniscus.

"As to sulphide of carbon it freezes at about −116° C., and melts at about −110° C.

"Alcohol becomes viscous, like oil, about −129° C., solidifying about −130·5° C., forming a white body."*

On April 10, another despatch was sent by M. Wroblewski:—

"Nitrogen cooled, liquefied by detent; meniscus visible, liquid colourless."

* *Comptes Rendus*, t. xcvi., p. 1140.
† *Ibid.*, t. xciv., pp. 1224—1226.

MEASUREMENTS OF THE WAVE-LENGTHS OF RAYS OF HIGH REFRANGIBILITY IN THE SPECTRA OF ELEMENTARY SUBSTANCES.†

By W. N. HARTLEY, F.R.S.E., &c., Professor of Chemistry, Royal College of Science, Dublin, and W. E. ADENEY, F.C.S., Associate of the Royal College of Science.

THE authors describe a method of taking photographs of diffraction spectra produced by a small Rutherford speculum ruled with 17,460 lines to the inch. The lines in the spectra were accurately measured by the aid of a microscope magnifying 25 diameters and a dividing engine.

The length of the spectra which were taken on three different plates was 14 to 15 inches, and the measurements were accurate to the $\frac{1}{10000}$th of an inch. From these measurements the wave-lengths of the lines were calculated. The spectra include lines with wave-lengths 4674 and 2024. They were produced by electric sparks condensed by a pane of glass coated with tin-foil.

Of the electrodes used *one always* consisted of cadmium, the other of the metal or the solution of the metal, or other elementary substance, the wave-lengths of the lines of which was to be determined; thus all the spectra were referable to the cadmium lines. Great accuracy is attainable by this method, and lines which have appeared identical or coincident in two different spectra have thus been proved to differ in refrangibility.

All the spectra were compared with spectra obtained with the prism spectroscope described by one of the authors in the *Scientific Proceedings of the Royal Dublin Society*, vol. iii., Part III., April, 1881.

Great care was exercised in taking the photographs, lest any irregularity in the surface of the plates should lead to inaccurate measurements. Gelatin films on specially selected *patent plate* glass were used, and such a precaution is quite necessary. The photographs were not varnished. A certain number of lines measured by previous observers have been compared with the new measurements. Taking the numbers given by Thalén, Lecoq de Boisbaudran, and Cornu for 150 lines in the spectra of magnesium, zinc, cadmium, aluminium, indium, thallium, iron, &c., a close agreement with their measurements affords satisfactory evidence of the accuracy of these determinations. Besides the wave-length, a very careful description of the appearance of each line is given, together with its linear measurement indicating its position on a series of photographs obtained with the prism spectroscope, which series of photographs is presented with the paper. A distinction is drawn between those lines determined directly with the grating and others too faint to be seen on diffraction photographs, which were measured by the aid of the prism spectroscope and an interpolation curve 9½ metres in length. The total number of lines measured and described is 2247, namely:—Magnesium, 42; zinc, 151; cadmium, 141; aluminium, 30; indium, 104; thallium, 70; copper, 164; silver, 124; mercury, 80; carbon, 20; tin, 129; lead, 86; tellurium,

* These experiments were made in the laboratory of M. Wroblewski, at Cracow.
† Abstract of a Paper read before the Royal Society, April 19, 1883.

322; arsenic, 112; antimony, 211; bismuth, 156; air, 215: and iron, 150.

A series of eighteen enlarged photographs, 36 inches in length, are presented with the paper, on which each line has its wave-length written over it.

ELECTRIC LIGHTING.

Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting.*

These rules and regulations are drawn up for the reduction to a minimum, in the case of electric lighting, of those risks of fire which are inherent in every system of artificial illumination, and also for the guidance and instruction of those who have, or who contemplate having, electric lighting apparatus installed in their premises.

The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing," or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the dangerous production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are either ordinarily or for the purpose of testing, passed through the circuit. Should wires become perceptibly warmed by the ordinary current, it is an indication that they are too small for the work they have to do, and that they should be replaced by larger wires. Bare or exposed conductors should always be within visual inspection, and as far out of reach as possible, since the accidental falling on to, or the thoughtless placing of other conducting bodies upon such conductors would lead to "short circuiting," and the consequent sudden generation of heat due to an increased current in conductors not adapted to carry it with safety.

The necessity cannot be too strongly urged for guarding against the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger.

The chief dangers of every new application of electricity arise from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

The greatest element of safety is therefore the employment of skilled and experienced electricians to supervise the work.

I. *The Dynamo-Machine.*

1. The dynamo-machine should be fixed in a dry place.
2. It should not be exposed to dust or flyings.
3. It should be kept perfectly clean and its bearings well oiled.
4. The insulation of its coils and conductors should be practically perfect.
5. All conductors in the Dynamo-Room should be firmly supported, well insulated, conveniently arranged for inspection, and marked or numbered.

II. *The Wires.*

6. Every switch or commutator used for turning the current on or off should be constructed so that when it is moved and left it cannot permit of a permanent arc or of heating.
7. Every part of the circuit should be so determined, that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and all junctions with a smaller conductor should be fitted with a suitable safety fuse or protector, so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.
8. Under ordinary circumstances complete metallic circuits should be used; the employment of gas or water pipes as conductors for the purpose of completing the circuit should not in any case be allowed.
9. Bare wires passing over the tops of houses should never be less than 7 feet clear of any part of the roof, and all wires crossing thoroughfares should invariably be high enough to allow fire escapes to pass under them.
10. It is most essential that joints should be electrically and mechanically perfect and united by solder.
11. The position of wires when underground should be clearly indicated, and they should be laid down so as to be easily inspected and repaired.
12. All wires used for indoor purposes should be efficiently insulated, either by being covered throughout with some insulating medium, or, if bare, by resting on insulated supports.
13. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses, like iron girders or pipes, they should be thoroughly protected by suitable additional covering; and where they are liable to abrasion from any cause, or to the depredations of rats or mice, they should be efficiently encased in some hard material.
14. Where indoor wires are put out of sight, as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.

N.B.—The value of frequently testing the apparatus and circuits cannot be too strongly urged. The escape of electricity cannot be detected by the sense of smell, as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering, by electric action.

III. *Lamps.*

15. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.
16. The lanterns, and all parts which are to be handled, should be insulated from the circuit.

IV. *Danger to Person.*

17. Where bare wire out of doors rests on insulating supports, it should be coated with insulating material, such as india-rubber tape or tube, for at least 2 feet on each side of the support.
18. To secure persons from danger inside buildings, it is essential so to arrange and protect the conductors and fittings, that no one can be exposed to the shocks of alternating currents of a mean electromotive force exceeding 100 volts, or to continuous currents of 200 volts.
19. If the difference of potential within any house exceeds 200 volts, the house should be provided with a "switch," so arranged that the supply of electricity can be at once cut off.

By Order of the Council.
F. H. Webb, *Secretary.*

Offices of the Society,
4, The Sanctuary, Westminster,
April 11, 1883.

* Recommended by the Council of the Society of Telegraph Engineers and of Electricians in accordance with the Report of the Committee appointed by them on May 11, 1882, to consider the subject. Members of the Committee.—Professor W. G. Adams, F.R.S., Vice-President; Sir Charles T. Bright; T. Russell Crampton; R. E. Crompton; W. Crookes, F.R.S.; Warren De la Rue, D.C.L., F.R.S.; Professor G. C. Foster, F.R.S., Past President; Edward Graves; J. E. H. Gordon; Dr. J. Hopkinson, F.R.S.; Professor D. E. Hughes, F.R.S., Vice-President; W. H. Preece, F.R.S., Past President; Alexander Siemens; C. E. Spagnoletti, Vice-President; James N. Shoolbred; Augustus Stroh; Sir William Thomson, F.R.S., Past President; Lieut.-Colonel C. E. Webber, R.E., Past President.

ON SOME

THEORETICAL CONSIDERATIONS CONNECTED WITH THE HARDENING AND TEMPERING OF STEEL.

By Professor CHANDLER ROBERTS, F.R.S.

THE Cutlers' Company of London have, during the past few years, instituted a series of lectures in connection with the general scheme for technical education. The last of the series for the present session was delivered on Thursday, April 12, by Prof. Chandler Roberts, F.R.S., "On some Theoretical Considerations connected with the Hardening and Tempering of Steel."

He traced the history of the subject, and, quoting Guyton Morveau, said that Stahl, the great supporter of the Phlogistic theory, considered that iron, "cemented" with carbon in closed vessels, gained phlogiston, and became in consequence steel; and this was the opinion of his disciples, who considered steel to be merely iron possessing the characteristics of a metal in a higher degree than iron, a view which will be found in the works of Henckel, Cramer, Gellert, Rinman, and Maquer. Bergmann (1781), to whom we owe the discovery of the fact that the presence or absence of graphite makes all the difference in the properties of wrought-iron, steel, and cast-iron, retained the phlogistic theory generally, although he considered that steel contains less phlogiston than wrought-iron. Professor Roberts pointed out that we are still repeating Bergman's question "How does the graphite act" in producing the singular difference between hard and soft steel. The early experimenters who followed Bergman knew the importance of establishing the action of carbon in converting iron into steel, and Clouet, in 1796, followed by others in this country, converted soft iron into steel by heating it with the diamond. In these early experiments furnace gases had not been excluded, and it was urged that they might have converted the iron into steel without the intervention of the diamond. A past master of the Company of Cutlers, Mr. W. Haseltine Pepys, repeated in 1815, Clouet's experiment, under conditions which left no doubt as to the action of the diamond, for he employed electricity as a source of heat, and thus avoided the action of furnace gases altogether.

It was then shown that in soft, tempered, and hardened steel respectively, the carbon has a "distinct mode of existence," and the evidence as to whether carbon in steel is *combined* in the chemical sense, or is merely *dissolved*, was considered at length. The chemical evidence given by Berzelius, Karsten, Gurlt, Forquinon, and recently by Sir F. Abel, the distinguished chemist of the War Department, was then reviewed. With regard to the "solution" theory held by Vandermonde, Berthollet, and Monge in 1786, there is the recent and important calorimetric work of Troost and Hautefeuille, who showed that in white cast-iron, and probably in steel, the carbon is merely dissolved, a view which the lecturer adopted, as he did not consider it to be in any way in opposition to the fact established by Abel, that the carbon left by the slow action of a chromic acid solution is in the form of a definite carbide.

The various physical, as distinguished from the chemical, theories which had been set forth from the time of Réaumur, 1722, to that of Akerman, 1879, to account for the "intimacy of the relation" of carbon to iron in hardened as compared with soft steel, were then described. In recent years much importance had been attached to the physical evidence as to the peculiar constitution of steel, and it had been shown that there is a remarkable relation between the amount of carbon contained in different varieties of steel and their electrical resistance. The latest work, however, in this direction has been done by Prof. Hughes, and his very interesting experiments on the effect of torsion on wires of wrought-iron, soft and hard steel, through which a current is passed, was then described. The effect of hardening in oil on the tensile strength of steel of different degrees of carburization was then shown by the aid of curves, and it was incidentally pointed out that in the case of the variety of steel used for the manufacture of coinage dies a variation of 1-10th per cent of carbon makes a great difference in the quality of the metal.

NOTE ON WATER ANALYSIS.

By LEROY W. McCAY, M.A., D.Sc.

IN estimating the organic purity of waters here in Princeton we have been accustomed to check the ammonia process of Wanklyn by the permanganate method of Dr. Tidy. Great difficulty, however, has always been experienced in hitting upon the precise moment at which the blue colour of the iodised starch disappears. In order to avoid this uncertainty and annoyance, and at the same time to escape the loss of time and trouble incident to a re-addition of permanganate, Prof. Cornwall suggested the use of protosulphate of iron. The suggestion appeared all the more worthy of consideration, inasmuch as both Kubel and Wanklyn, the former in his method for estimating nitrites in drinking waters, the latter in his so-called moist-combustion process, make use of ammonium ferrous sulphate as an auxiliary in the determination of the amount of permanganate reduced or of oxygen consumed, and, in consequence thereof, I at once set to work and made up a solution of the double salt, which I have found to work most admirably. The strengths of my solutions are as follows:—

0·395 grm. potassic permanganate in 1000 c.c. pure water.

4·900 grm. ammonium ferrous sulphate in 1000 c.c. pure water.

To keep the solution of the double salt clear it will be found to be well to substitute for 25 c.c. of the pure water 25 c.c. of concentrated sulphuric acid.

I have, by repeated and numerous experiments, assured myself that not only are the results constant, but that their agreement with the figures obtained by the use of Dr. Tidy's hyposulphite, potassic iodide, and starch method are all that could be desired. The following figures will serve to indicate the degree of agreement between the results as obtained by each method:—

	Hyposulphite.	Ammonium ferrous sulphate.
1. ..	0·351 ..	0·365
2. ..	0·092 ..	0·086
3. ..	0·050 ..	0·050
4. ..	0·030 ..	0·036
5. ..	0·038 ..	0·032
6. ..	0·023 ..	0·028
7. ..	0·090 ..	0·096
8. ..	0·030 ..	0·020

When we take into consideration the fact that a water consuming 0·05 grm. oxygen per 100,000 c.c. may be regarded as excellent, and, moreover, that a difference in reading of 0·25 c.c. on the chameleon burette will occasion a difference of 0·01 grm. oxygen, I think that all will agree with me in concluding that the above figures are satisfactory, and that the ammonium ferrous sulphate method is as delicate and exact as that of Dr. Tidy's, involving the use of the hyposulphite, potassic iodide, and starch.

By making use of the double salt: 1. The uncertainty connected with the precise moment of disappearance of the blue of the iodised starch is avoided. 2. A considerable amount of time is saved. 3. Two solutions alone are requisite for making an estimation; and 4. The amount of chemically pure water is reduced to a minimum.

The ammonium ferrous sulphate solution keeps remarkably well. In two weeks I have been unable to detect a trace of change. I keep my solution in a large green bottle and in the dark.

John C. Green School of Science,
Princeton College, Princeton, N.J.

ON SECONDARY BATTERIES.*

By GEORGE F. BARKER, Philadelphia, Pa.

A SECONDARY battery is one which produces a current in consequence of a previous electrolytic condensation or polarisation upon the surfaces of its plates. Electrolytic polarisation and the production of a secondary current by means of it are almost as old as the voltaic battery itself. In 1801, Gautherot, having used platinum or silver wires as electrodes in a solution of salt, noticed a momentary inverse current when the battery was replaced by a galvanometer. Ritter observed the same phenomenon in 1803 with gold wires. He constructed a secondary battery with pieces of gold separated by cloth disks moistened with salt water. After contact for some seconds with a Volta's pile of more pairs than itself, it produced a current to which Ritter gave the name of secondary current. Platinum, gold, and silver gave a more marked result than copper, brass, iron, or bismuth; and no effect at all was obtained from lead, tin, or zinc. Fifty disks of copper separated by disks of cloth moistened with salt or sal ammoniac solution, when charged with a Volta's pile of 100 pairs, gave a current which decomposed water and produced all the effects of the primary current. Volta himself, as well as Marianini, explained the results by supposing that the decomposition of the salt produced acidic and basic deposits upon the metal disks; a view which Becquerel apparently confirmed by immersing a platinum plate in an acid, and another in an alkali, and noting that the current was the same in direction as the secondary current. But in 1826 De la Rive obtained the secondary effect from platinum plates immersed in dilute sulphuric acid; and since no basic or acidic deposits were now possible, he regarded the phenomenon as a physical one due to a special or polarised condition of the plates themselves. The current he called a polarisation current. In 1833-4 Faraday's researches on electro chemical decomposition definitely established the proportionality of the current to the amount of electrolyte decomposed. He observed the "peculiar state" of the plates in his voltameter; and even noticed that when lead acetate was electrolysed, metallic lead was deposited on the negative plate and lead peroxide on the positive; but he offered no explanation of these phenomena. In 1842, Grove, following out an observation of Matteucci, constructed a gas battery in which the current was produced from two plates of platinum immersed in oxygen and hydrogen gases respectively. In 1852, C. W. Siemens used two carbon plates in lead acetate solution as a secondary battery, obtaining, by the action of the current, lead on one of these plates and lead peroxide on the other. One cell of this battery decomposed water; so that the electromotive force of the current must have been nearly two volts.

In 1859 Planté began an elaborate research upon this secondary action, studying carefully the influence of the metal and of the solution employed. The maximum effect was given by lead plates immersed in dilute sulphuric acid; and in 1860 he produced secondary batteries of remarkable power by rolling two sheets of lead together, a strip of insulating material being between them, and placing them in a ten per cent sulphuric acid. When connected with a battery, the oxygen evolved upon the positive plate attacked it and converted its surface into peroxide, the hydrogen for the most part escaping. When now the current was reversed the hydrogen reduced this peroxide to finely-divided metallic lead, and the oxygen attacked the other plate, producing peroxide. By such alternations the metal may finally be corroded to any depth, and the amount of finely-divided lead and peroxide indefinitely increased. In Planté's experiments this forming process required three months. In 1881 Faure brought out a secondary battery in which, as in Planté's, lead plates in sulphuric acid were employed. But in order to avoid the tedious process of "forming," in which the deposits upon the plates were produced by electric action, Faure covered the plates at the outset with a layer of minium or red lead. Upon passing the current this red lead was reduced to metallic lead on the one plate and oxidised to peroxide on the other; thus producing the battery charged and ready for use in a single operation requiring but a few hours.

The theory of the storage of energy by secondary batteries is not difficult. Energy is capacity of doing work, and work is force acting through distance. Whenever two attracting bodies are separated work is done upon the system and energy is absorbed by it; and this whether the attraction overcome is mechanical, molecular, or atomic. When an electrolyte is decomposed by an electric current, the current yields energy in proportion to the amount of the ions separated. The quantity of lead peroxide formed in a secondary battery represents the amount of energy stored from the current. So soon, however, as the separating force ceases to act the ions reunite and the stored energy becomes again free. Since the amount of energy thus set free, like that originally stored up, is proportional to the quantity of matter concerned, it is clear that the amount of electricity obtained from a given secondary battery is proportional to the amount of electrolytic products deposited upon its plates. In theory, the electrical energy set free should equal that originally stored up, but in practice this result is never attained.

In its primary expression the chemistry of the secondary battery is simple. In the form made by Grove two platinum plates are placed in acidulated water. Under the action of the current oxygen is set free on one of these and hydrogen on the other,* and the plates are said to be polarised. The electromotive force between these plates is the sum of the contact-potentials involved. Its value is 1·45 volts, and it measures the chemical attraction between oxygen and hydrogen. If now the two plates be connected by wire, the oxygen and the hydrogen recombine and the energy of combination appears in the form of a secondary current. In general, however, the electrolytic action is accompanied by secondary chemical changes which render the phenomenon much more complicated. In the lead battery, for example, secondary products appear at both electrodes. The oxygen set free at the anode combines with the lead, the final product there being peroxide. The hydrogen evolved at the cathode reduces the oxide which it finds there and produces metallic lead. As before, the electromotive force in the battery is the sum of the contact-potentials, and this, in the case of lead and lead peroxide, is a little above two volts.† When now the plates are connected by a conductor the entire process is reversed. Water is decomposed, and, since the immersed portion of the plates changes sign on discharge, the hydrogen now goes to the peroxide surface and oxygen to the finely-divided metallic lead. The former is deoxidised to monoxide, and the latter oxidised to the same condition. Simultaneously, a current flows through the conductor, the electromotive force of which is two volts, the strength of which is the ratio of this electromotive force to the resistances in circuit,

* From the *Proceedings of the American Association for the Advancement of Science*, Montreal Meeting, 1882.

* Undoubtedly the oxygen is produced by a secondary reaction.

† Planté observes that, after complete charging, the electromotive force may rise above two volts at the instant of removing the battery. But as it falls to this value at once on closing the circuit and remains so, he attributes the first result to the temporary production of a peroxidised substance, as hydrogen peroxide or persulphuric acid, at the anode.

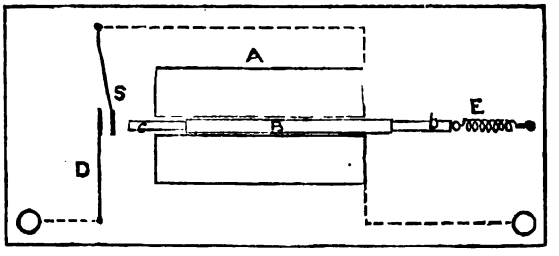
and the duration of which depends upon the amount of secondary products deposited upon the plates during the charging. Beside this, however, another action takes place in the secondary battery which is of great importance. The sulphuric acid in which the plates are immersed attacks both the peroxide on the one plate and the metallic lead on the other, and converts both into lead sulphate. Moreover, as fast as the monoxide is produced by the discharge of the battery, it also is converted into sulphate; so that upon complete discharge the plates are precisely alike, both being covered with lead sulphate.

The secondary batteries employed for experiment were those of Planté and Faure. Of the former type, two cells of the larger size made by Breguet were used. Of the latter, one cell of medium size made by Reynier, and thirty-four cells of the size exhibited at the Electrical Exhibition at Paris, were experimented with. The battery of thirty-four cells was made in January under my direction.* Each cell consisted of six plates, each 20 by 60 centimetres, the lead being a millimetre thick. The exposed surface of each plate, therefore, was nearly 0·25 of a square metre, and of each cell about 1·50 square metres. For the whole battery the surface was about 50 square metres (exactly 48·96). Each plate was covered on both sides with a coating of red-lead about a millimetre thick made into a paste with water. Parchment-paper was then folded over the whole, and over this a covering of felt sewed together at the edges. The plates were then folded transversely and each pair intercalated. Heavy lead terminals were attached to each plate, and three pairs of plates were placed in each box, the terminals of one plate of each pair being united together and furnished with a connector. The boxes were lead-lined, and measured 31 c.m. in length, 25 in depth, and 11 in width. One of the two sets of plates was in contact with the lead lining, the other was insulated. The latter was always made the positive end. The total weight of a single cell was 17 kilogrms.†

The charging current was generated by a Gramme machine whose field was maintained by an auxiliary dynamo. The maximum obtainable electromotive force of this current was 85 volts. In general, however, a much less electromotive force was used, sufficient only to give a current of from 10 to 20 amperes through the thirty-four cells arranged in series. Currents as high as 45 amperes, however, were occasionally employed. At the outset considerable difficulty was experienced from the discharge of the battery when from any accidental cause the current fell below the potential of the thirty-four cells. The wear of the brushes of the auxiliary dynamo sometimes opened its circuit and thus destroyed the magnetic field of the Gramme. There being now no counter electromotive force to oppose it, the secondary battery flowed back through the machine, discharging the battery completely. A simple device was arranged to prevent loss of the charge in this way should the charging current become weakened. This device is represented in Fig. 1, where A is a coil of No. 10 copper wire. Within its core is a rod of iron, B, prolonged at both ends by brass rods of smaller diameter, *b* and *c*, these being supported upon rollers. Opposite the end of one of these rods is a flat spring, S, faced with platinum and making contact when depressed with a similar brass strip D, also faced with platinum. The course of the current is shown by the dotted lines. When the circuit is closed between S and D, the current traversing the coil draws the iron bar strongly into its axis, and the end of the brass rod pressing against S holds the circuit closed. Should the current weaken, the spring S reacts against the rod, pushing it back and opening the circuit. By means of an auxiliary spiral spring, E, the instrument may be adjusted to any required current-strength. It would seem that by no possibility can the accumulated charge in the battery be lost when this automatic cut-out is in circuit. As now described, the coil is of large wire, and the entire current passes through it; but a second form of it has been used in which the coil is made of finer wire, and is placed in a shunt circuit, as shown in Fig. 3. In both cases, of course, the entire current passes through the contact springs.*

After charging, the current from the secondary battery was used to maintain seventeen Edison incandescent lamps of the B pattern. More frequently, however, the

Fig. 1.



battery was used in connection with the Gramme machine. The source of power being an Otto gas-engine which, at best, has an explosion only every fourth stroke, the motion appears very irregular when tested by so delicate a method. As every explosion increases the speed, the higher electromotive force developed increases for an instant the brightness of the carbon filament, producing a marked pulsation in the light. If now a secondary battery of nearly the same electromotive force be placed in multiple circuit with the machine and lamps it acts as an equaliser, and destroys entirely the pulsations. Figs. 2 and 3 show the arrangement actually employed, in which B is the secondary battery and L the lamps, the automatic cut-out being at C. When the circuit is opened at *a*, *b* and *c* being closed, the lamps are fed by the machine alone; when opened at *b*, *a* and *c* being closed, by the battery alone: when at *c*, *a* and *b* being closed, the machine charges the battery. When all three are closed, the lamps are fed by the machine and battery together, the latter acting as an equaliser. A galvanometer inserted at *a*, *c* being opened and *b* closed, indicates the charging current: when *c* is closed and *b* open, the discharge current; and when *b* and *c* are both closed, the equalising current. If the electromotive force of the machine current be but slightly in excess of the battery current, the deflection to the right in the first case will about equal that to the left in the second; so that in the third case the deflection is practically zero, not the least spark appearing on opening at *a*; and this,

* This battery, as well as the cut-out, Fig. 1, was made by Jas. W. Queen and Co., of Philadelphia.

† Mr. W. Lachlan, the electrical engineer of the Light and Force Co., New York, has kindly furnished me the following figures concerning the Faure batteries of improved construction recently imported in the steamer *Labrador*. Four types of Faure batteries are made in Paris, called A, B, C, and D. Type A consists of seven positive plates, each 37×23·5 c.m., and 3 m.m. thick, perforated with holes 6 m.m. in diameter 10 m.m. apart, alternated with seven negative plates of the same size, but only 0·5 m.m. thick, and similarly perforated. The seven positive plates weigh 16·66 kilogrms.; the seven negative ones 2·77 kilogrms. The red-lead spread on their surfaces weighs 22·13 kilogrms., the two exterior plates being covered only on their interior surfaces, so that there are twenty-six active surfaces in all. Each plate has an electrode 7 c.m. wide. The box is 45×20×40 c.m. in size, is pitched throughout, and weighs with its cover 10 kilogrms. The battery complete, ready for charging, weighs 63 kilogrms. In type C there are five positive plates each 24×19 c.m., 3 m.m. thick, and four negative plates 0·5 m.m. thick, both perforated with holes 5 m.m. in diameter, and a centimetre apart. The positive plates weigh 7·14 kilos., the negative 0·888 kilo. Sixteen surfaces are covered with red-lead, weighing 8·28 kilos. The electrodes are 3·5 c.m. wide. The box weighs 3 kilos., and the battery complete 20·37 kilos. Each cell of type A contains, it is claimed, when fully charged, 375 ampere-hours of current delivered at an electromotive force of 2 volts. Hence it will furnish, for example, a current of 25 amperes for fifteen hours. Type C contains 153 ampere hours. Types B and D are round cells in jars of earthenware. The former weighs 35 kilos., and contains 225 ampere-hours: the latter 8 kilos., and contains 75.

* Sir W. Thomson has devised a polarised cut-out for this same purpose. He exhibited it at the York meeting of the British Association in September last.

though the pulsations are completely destroyed, the light being perfectly steady. The advantage of a much more agreeable light is thus secured; but, in addition, the life of the lamps must be increased by the use of this steadier current, as it has been shown to be by using the secondary battery alone.

On the 27th of February the battery was charged continuously for fourteen hours, or until hydrogen was freely evolved from each of the 32 cells employed. It then gave an electromotive force of 59·3 Daniell cells; or calling the Daniell 1·08 volts, of 64·04 volts. On the 10th of June, the same 32 cells gave an electromotive force of 56·7 Daniell's, or 61·2 volts. On the 24th of June, their electromotive force was 54·3 Daniels, or 58·6 volts. It may be assumed then that the average electromotive force of a single cell was not far from 2 volts. This value has never been exceeded in any of the measurements made, either on single cells or on groups of cells. When first made the resistance of the single cells was low, about 0·02 ohm; but subsequently the internal resistance increased considerably, rising even to twice this value.

The chief defect of the secondary lead battery is the local action which takes place in it. By local action is meant any deterioration in the efficiency of a battery which occurs when it is left on open circuit. This defect was noticed by Planté, who says: "If the lead peroxide deposited on the positive plate had no tendency to spontaneous reduction in the acidulated water, by forming a local circuit with the metal that it covers, the preservation of the charge taken by the secondary couple should be indefinite. But this peroxide is reduced, and with the more facility, as the layer of it is thinner. In a new secondary couple the charge cannot be preserved." In a well-formed battery he attributes the preservation of the charge to a reduction of the superficial layer to monoxide, which acts as a protecting coating. Another local action, however, takes place in this battery which appears to be of more importance. This is the action of the sulphuric acid upon the products of electrolysis. The finely-divided lead on the negative plate, as well as the peroxide upon the positive, is alike converted into sulphate by this action. When the circuit is closed this action is normal; but it takes place equally well when the circuit is open. It is then abnormal and of course injurious. The formation of lead sulphate in the secondary battery has been studied by Gladstone and Tribe.* They found that with a Planté cell the whole of the peroxide formed on charging was converted into white sulphate within seventeen hours. The same fact was observed with the Faure battery. So far, however, from regarding this formation of sulphate as wholly injurious, they regard it as "absolutely requisite in order that the charge should be retained for a sufficient time to be practically available." They believe that the insoluble lead sulphate clogs up the interstices of the per oxide and after a while forms an almost impermeable (*sic*) coating between it and the lead plate; so that the mass of peroxide which is in contact with the lead plate expends its energy slowly, while the same mass of peroxide, brought into connection through its own lead plate with another lead plate at a distance, expends its energy even through the sulphuric acid, in a tenth or a hundredth part of the time.

My experiments with the Faure battery above described confirm entirely those of Gladstone and Tribe as to the formation of lead sulphate. In several cases, the acid in charged cells disappeared entirely on standing, so that the water was tasteless; and in some instances this was repeated three times with the same set of plates. This action increased very greatly the internal resistance, first by replacing the acid by water, and second by forming the higher resistant sulphate. On examining the plates, lead sulphate formed the entire coating upon both of them. On attempting now to re-charge such a cell, this notable increase in the resistance showed itself in the reduced current transmitted by the same electromotive force. Gradually, however, the resistance fell, and the current finally regained its normal strength. In one instance, the charging current rose from 2 amperes to 12 in four hours, 28 cells being in circuit, arranged in series. It was observed, however, that when the current was first applied, torrents of gas were evolved from both plates; and that as the charging process went on the oxygen was first completely absorbed, and then the hydrogen. When the charge was nearly complete the evolution of hydrogen reappeared. There would seem, therefore, to be a very considerable loss of energy, due to the resistance consequent upon the formation of sulphate. In the first place the current energy is wasted as heat in the cells; and in the second, a large portion of it is dissipated in the evolved gases.

Another defect of considerable magnitude is developed when a number of secondary cells is placed in series, and is due to a want of uniformity in their capacity for storage. This arises, probably, first, from the difficulty of constructing them exactly alike originally, and second, from the impossibility of uniform action among them on charge and discharge. The difference in the cells of the same

FIG. 2.

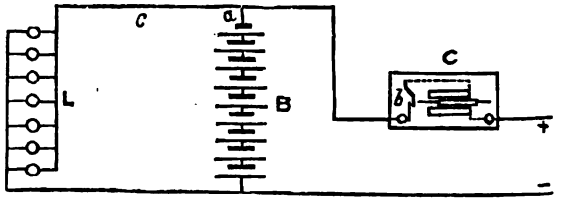
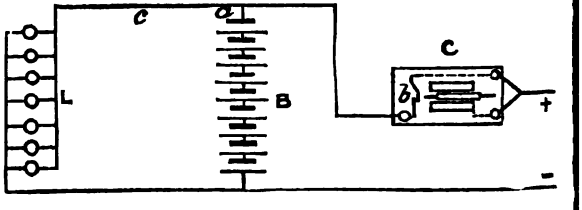


FIG. 3.



battery even, when they all have been treated precisely alike, is surprising. On the 14th of June, 32 cells were freshly charged, and the current strength from each cell measured on a tangent galvanometer. Eleven cells gave 80° deflection each, seventeen gave 79° each, one gave 78°, one 77°, one 75°, and one 20°. When seventeen Edison B lamps were placed in circuit, the discharge deflection of the thirty-two cells in series was 67°. On the following day the battery was charged again, and, after an hour's use on the lamp circuit, was again tested. Those giving a deflection of 87° were two; of 86°, two; of 84°, two; of 83°, one; of 81°, one; of 78°, five; of 77°, two; of 76° one; of 13°, three; of 11°, one; of 10°, three; of 8°, one; of 6°, one; of 5°, three; of 4°, one; of 2°, one; of 1°, one; and of 0°, one. Obviously, so long as any peroxide is present, the electromotive force is constant; hence this wide variation of current strength must be attributed apparently to the variation of the resistance in the different cells. But this is not the worst aspect of the matter. If the discharge be continued for a longer time, some of the cells become exhausted sooner than others, and are then charged in the inverse direction by the current from the rest. On the 12th of June, the thirty-two cells, after pretty complete discharge, were measured as above. Nineteen cells gave positive deflections ranging from 87° to 5°; thirteen gave negative deflections varying from 13° to 1°. Faraday said of primary batteries in 1834, that "weak and exhausted charges should never be used

* *Nature*, xxv., 221, 461; xxvi., 251, 1882.

at the same time with strong and fresh ones in the different cells;" and this remark is even more applicable to secondary batteries, where this condition is more liable to occur. Not only does a dead cell introduce resistance into the circuit, but what is of more importance, its reverse polarisation introduces a counter-electromotive force, so that every such cell neutralises another cell, the dead resistance of which is also added to the circuit. In consequence, it is not safe in practice to draw from a secondary battery all the energy it should be capable of yielding, and in most cases not more than half can be safely taken out of it. In place of continuing uniform as in a single cell, the electromotive force of a series of cells begins to fall when about half the charge which it ought to be capable of yielding has been drawn from it. The practical result is that to supply for lighting a definite number of coulombs of electricity, a secondary battery of twice the size is necessary under these circumstances.

With reference to the two forms of lead secondary battery devised by Planté and by Faure respectively, my experiments show that while the electromotive force is the same in both, and while the internal resistance and storage capacity may readily be made the same, yet that the local action is far less when the peroxide is formed by the action of the current upon the lead plate itself than when it is produced from minium spread upon it. The rapidity of the formation of the peroxide is proportional to the density of the current; but when rapidly formed it is fine and spongy. In one of my Planté cells, the peroxide is beautifully crystalline and very hard. Not a trace of sulphate has been formed in it apparently, though it has been in use for six months, and has been frequently charged and discharged during that time. The necessarily finer condition of the peroxide in the Faure battery would seem to predispose it to a more considerable local action. True, the Faure battery requires very much less time than the Planté to form it. But this is more than compensated by the increased permanence of the latter. With an equal storage capacity, as in M. de Kabath's form of Planté cell, it would appear that in efficiency it will surpass the form devised by Faure.

The commercial aspect of the question of the storage of electrical energy has recently assumed a very considerable importance. But it is evident at the outset, that an agent, which has been produced and then stored, must cost more when re-delivered than when first produced, by exactly the cost of the storage; that is, supposing there is no loss in storing. But there is a loss, and this is almost if not quite one-half of the energy involved; as it would seem from the Conservatoire experiments in Paris, among others. The first cost of the accumulators, the expense of charging them, their low efficiency, and especially their bulk and weight, must ever prevent, it would seem, their competing successfully with the direct use of the dynamo-electric machine, at least with any form of secondary battery yet devised. For special uses, however, the storage battery has a high value. Even if the cost of an ampere of current produced by it is twice as great as if produced directly by the dynamo-machine, this cost is only one-half of that required to give the same current by any available form of primary battery. Where a strong current of low electromotive force is needed, under conditions where a dynamo cannot be employed, there the secondary battery has its most important field. Its value rapidly decreases as the number of cells is multiplied, as when a high electromotive force is needed for the production of light. Its chief advantage is its transportability; since by placing it near the work to be done, the loss of energy on long conductors is obviated.

Weathering of Marley Detritus and the Changes produced by Cultivation.—Prof. A. Orth.—The upper stratum of soil in comparison with the sub-soil becomes richer in lime, carbon dioxide, and phosphoric acid, but poorer in potassa.—*Biedermann's Central-Blatt.*

ON THE

PREPARATION OF CERIUM OXIDE.

By M. H. DEBRAY.

FIVE hundred grammes of cerite, finely powdered, are stirred up in, at most, an equal weight of water, and 375 grammes of concentrated sulphuric acid are added whilst the mixture is being rapidly stirred. This operation is performed in a large platinum capsule with a flat bottom. The mixture becomes hot, swells up, and is rapidly converted into sulphates of the earths of cerite, and into gelatinous silica. The whole is evaporated until dense fumes of sulphuric acid begin to appear, stirring all the time to prevent the mass from adhering to the bottom of the capsule. The matter is then pulverulent, and the silica has become insoluble. When it is quite cold, it is thrown, little by little, into water kept at 0° by means of ice (5 or 6 litres at least); the sulphates, which are slightly acid, dissolve readily in the water if we prevent the rise of temperature which accompanies hydration. The liquid is filtered off and treated with a current of hydrogen sulphide; when saturated with this gas it is let digest for twenty-four hours. A complex mixture of copper, bismuth, molybdenum, &c. sulphides, is deposited. The mixture is heated to cause these sulphides to be perfectly precipitated, and filtered. The rose-coloured filtrate is precipitated with concentrated oxalic acid. There is formed an abundant curdy deposit, which collects at first in a soft state at the bottom of the vessel, and is rapidly converted into a crystalline powder of the acids of the cerite earths. The acid liquid contains lime and iron. The oxalates are washed by decantation and converted into nitrates by attacking them with hot concentrated nitric acid.

So far the treatment indicated does not essentially differ from that commonly adopted for extracting from cerite the mixture of earths discovered by Mosander. It is chiefly in the treatment of the nitrates for obtaining cerium oxide that the process is distinguished from those hitherto adopted for separating ceroso-ceric oxide from the didymium and lanthanum oxides.

The mixture of nitrates is melted with 8 or 10 parts potassium nitrate in a porcelain capsule, and the fused mass is kept between 300° and 350° by means of a gas furnace. Cerium nitrate is decomposed, forming a yellowish powder of cerium oxide, which retains a little nitric acid, but didymium and lanthanum nitrates, when melted with nitre, are not appreciably decomposed, even at 350°. A thermometer, plunged into the bath of nitrate, indicates its temperature. When the escape of nitrous fumes ceases, which requires several hours, the operation is stopped. When cold the melted mass is easily detached from the capsule, and the cerium oxide is found collected at the lower part. It is dissolved in water, and there remains a powder, yellowish if it contains mere traces of didymium, but reddish if it contains more. It is well to wash with a little weak nitric acid, which dissolves a little didymium sub-nitrate produced at the same time as the cerium oxide if the capsule is too strongly heated at certain points. This is of little consequence as the cerium oxide obtained in the first operation always requires to be purified.

It may be entirely freed from didymium by transforming it into nitrate, which is melted a second time with 8 or 10 parts potassium nitrate. For this purpose the oxide is attacked with sulphuric acid diluted with an equal volume of water, taken up with water when everything dissolves if the liquid is sufficiently acid. The yellow ceroso-ceric sulphate thus obtained is reduced with sulphurous acid, and the cerous sulphate is precipitated with oxalic acid. The cerous oxalate is then readily converted into nitrate by boiling with nitric acid. This second treatment gives a yellow powder, which contains neither didymium nor lanthanum, as the nitrate of the latter earth is still more stable than that of didymium. If it is

transformed into colourless cerous sulphate the spectroscope does not detect the least trace of this body, which is always easy to recognise by its absorption-spectrum. The didymium and lanthanum nitrates which remain mixed with a large excess of potassium nitrate are evaporated and re-melted, the temperature exceeding 350°. The remaining trace of cerium nitrate which has escaped decomposition in the former operation is completely destroyed, and there is even formed a small quantity of didymium sub-nitrate. But the bulk of the didymium remains with the lanthanum in the state of a soluble nitrate.

We have thus a certain and rapid method of obtaining the oxide or the salts of cerium free from didymium and lanthanum, or, on the other hand, a mixture of these two oxides absolutely free from cerium.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 19, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—C. Beringer, H. E. Harrison, C. Hulke, E. H. B. Stephenson, A. Smith. During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Messrs. Spiller and Groves, to be duly elected Fellows:—T. L. Briggs, J. A. Basker, J. B. Coleman, W. H. Cannon, E. C. Conrad, C. Gillett, E. C. Hemming, N. K. Humphreys, L. Levy, A. Ness, V. T. Schopoff, A. E. Wilson.

The PRESIDENT called on Dr. PERCY FRANKLAND to read a paper "*On the Gases evolved during the Conversion of Grass into Hay*," by P. F. FRANKLAND and F. JORDAN. About 5 grammes of finely-cut grass were imprisoned in a small retort adapter, which was then filled with mercury, the small end of the adapter corked up, the cork protected by a mercury cup, and the whole allowed to remain over mercury during the observation. In atmospheric air at 15° C., 3 c.c. of gas were evolved in three days, and 4 c.c. more in thirty days. The gas in the first case was composed of—CO_2, 46·35 per cent; O, 0·07 per cent; N, 53·58 per cent. In the second case—CO_2, 85·33 per cent; O, 0·00 per cent; N, 14·67 per cent. Other experiments were made in which the grass was surrounded by atmospheres of carbonic anhydride, of hydrogen, and of oxygen, with almost similar results. The authors conclude that the atmosphere with which the grass is surrounded has but little influence either upon the volume or the composition of the gas evolved. The grass in every case undergoes a rapid process of oxidation, in which it speedily removes all the oxygen from the atmosphere, with which it is surrounded, and in the absence of any oxygen in the free state, with which to combine, much carbonic acid is produced at the expense of the combined oxygen present in the grass. When, however, free oxygen is present in the atmosphere surrounding the grass, the gas evolved contains a considerable proportion of nitrogen. At a temperature of 36° C. more gas is evolved than at 15°. In all cases carbonic anhydride is the chief product of decomposition, whilst hydrogen and hydrocarbons appear in only very small quantities. The authors have made similar experiments as to the gases evolved by grass when kept under water. Large volumes of gas are evolved (about five times as much as in the previous experiments), which are characterised by the presence of a notable proportion of hydrogen, which is doubtless due to the lactic fermentation induced by bacteria: acetic, lactic, and probably propionic acids with bacteria being found in the water. If the water contain phenol or mercuric chloride, or if the grass be steamed, no gas is evolved.

Dr. VOELCKER said the paper was peculiarly interesting, not only from a scientific point of view, but from its direct bearing on the making of hay in wet weather, and on the preservation of grass as "ensilage." The changes observed when the grass was immersed in water were those which take place in the "silo." He had examined some "ensilage" from Boston, and had found considerable quantities of propionic and acetic acids. These acids are the best preservers of green food; the grass is, in fact, pickled. Well-made ensilage can be exposed without becoming mouldy; it contains no sugar. It would be interesting to know to what extent, as indicated by loss of weight, the changes observed by the authors had taken place. He had made some observations at Rothamsted on a stack of hay, made in dry weather under the most favourable conditions, and the loss was only 5 per cent. On the other hand, a stack made in wet weather at Cirencester, had become so hot that it had to be taken down, and the quantities of carbonic anhydride, aldehyd, and acetic acid completely overpowered the men employed. In the lower part of this stack the grass was completely calcined, and 5 or 6 lbs. of ash were collected. Now it would be extremely interesting to determine quantitatively the loss which grass undergoes when improperly stacked, and to study the effect of temperature on these changes.

The PRESIDENT asked if any experiments had been made as to the composition of the combustible gases evolved; whether any marsh-gas was present?

Dr. PERCY FRANKLAND said he had not been able to weigh the grass after the experiments, and that most of the combustible gas was absorbed by strong sulphuric acid.

Dr. L. T. THORNE then read a "*Note on an Apparatus for Fractional Distillation under reduced Pressure.*" By means of this apparatus, which was exhibited by the author, the various fractions can be removed from time to time without impairing the vacuum, and the distillation can therefore be continued from beginning to end without interruption. If the substance under distillation is affected by exposure to the air, any inert gas can be introduced instead of air without disturbing the apparatus.

The PRESIDENT said that the apparatus had been in use in his laboratory for some time; it seemed to be very convenient, and answered extremely well.

Mr. W. H. DEERING then read a paper entitled "*Notes on the Condition in which Carbon exists in Steel,*" by Sir F. A. ABEL, C.B., and W. H. DEERING. Two series of experiments were made. In the first series discs of steel 2·5 inches in diameter and 0·01 inch thick were employed. They were all cut from the same strip of metal, but some were "cold-rolled," some "annealed," and some "hardened." The total carbon was found to be "cold-rolled," 1·108 per cent; hardened, 1·128 per cent; and annealed, 0·924 and 0·860 per cent. Some of the discs were submitted to the action of an oxidising solution consisting of a cold saturated solution of potassium bichromate with 5 per cent by volume of pure concentrated sulphuric acid. In all cases a blackish magnetic residue was left undissolved. These residues, calculated upon 100 parts of the discs employed, had the following compositions:—"Cold-rolled" carbon, 1·039 per cent; iron, 5·871. Annealed, C, 0·83 per cent; Fe, 4·74 per cent. Hardened, C, 0·178 per cent; Fe, 0·70 per cent. So that by treatment with chromic acid in the cold nearly the whole of the carbon remains undissolved with the cold-rolled and annealed discs, but only about one-sixth of the total carbon is left undissolved in the case of the hardened disc. The authors then give a *resumé* of previous work on the subject. In the second part they have investigated the action of bichromate solutions of various strengths on thin sheet-steel, about 0·008 inch thich, which was cold-rolled, and contained—Carbon, 1·144 per cent; silica, 0·166 per cent; manganese, 0·104 per cent. Four solutions were used. The first contained about 10 per cent of bichromate, and 9 per cent of H_2SO_4 by weight;

the second was eight-tenths as strong, the third about half as strong, the fourth about one and a half times as strong. In all cases the amount of solution employed was considerably in excess of the amount required to dissolve the steel used. A residue was obtained as before. With solution 1, the residue contained, C, 1·021; sol. 2, C, 0·969; sol. 3, C, 1·049 (the atomic ratio of iron to carbon was Fe, 2·694 : C, 1; Fe, 2·65 : C, 1; Fe, 2·867 : C, 1); sol. 4, C 0·266, per 100 of steel. The authors conclude that the carbon in cold-rolled steel exists not simply diffused mechanically through the mass of steel, but in the form of an iron carbide, Fe_3C, a definite product, capable of resisting the action of an oxidising solution (if the latter is not too strong), which exerts a rapid solvent action upon the iron through which the carbide is distributed.

Mr. SPILLER said that there was perhaps a possibility of decomposing the carbide of iron if all the iron present was dissolved, and suggested that it would be preferable to leave a little iron undissolved to prevent this risk.

Mr. DEERING said that it seemed to him the only natural stopping-point was to dissolve as much as possible with a given solution, and examine the residue.

"*On the Spectrum of Beryllium, with Observations Relative to the Position of that Metal among the Elements*," by W. N. HARTLEY. Owing principally to the difficulty of obtaining beryllium pure it is still questionable whether beryllium is a triad with atomic weight 13·8 and oxide Be_2O_3, or a dyad with atomic weight 9·2 and oxide BeO. The author has photographed the spark spectrum from a saturated solution of the chloride, prepared from pure oxide, presented to him by Dr. Emerson Reynolds, and concludes that beryllium is the first member of a dyad series of elements, of which in all probability calcium, strontium, and barium are homologues.

The Society then adjourned to May 3.

PHYSICAL SOCIETY.

Saturday, April 14th, 1883.

Professor G. C. FOSTER in the Chair.

NEW members—Mr. W. F. Smith, Mr. George Forbes, M.A.

Mr. W. LANT CARPENTER read a paper on "*Science Demonstration in Board Schools*," in which he showed the drawbacks of the present system of leaving science to be taught by the other masters, and pointed out the marked advantages of the system followed in Birmingham and Liverpool, where skilled lecturers are appointed to go from school to school, and provided with an assistant demonstrator and proper apparatus. Mr. Carpenter advocated the extension of this system to London and the country in general. He also showed the evil of the present system of cramming for examinations.

Dr. W. CARPENTER pointed out the advantages of object lessons in training the minds of children.

Dr. J. H. GLADSTONE stated that much had been done in London to introduce object lessons, and that under the Mundella code science would be taught in all Board Schools to all the children, who, however, might have the opportunity of choosing between science and literature.

Mr. W. BAILY, Prof. FOSTER, and Prof. W. CHANDLER ROBERTS also advocated the system of special science teachers.

Prof. ROBERTS then took the Chair, and

Mr. GLAZEBROOK explained a New Polarising Prism, which he had devised to prevent displacement of the pencil of rays. He also showed how the curved diffraction gratings of Prof. Rowland do not always give perfect definition, and calculated the aberration of the rays.

The SECRETARY then read a paper by Mr. W. H. STOKES and Mr. A. E. WILSON on "*Experiments on the Viscosity of Saponine*." When a disc is rotated in water the resistance to its motion is greatest when the plate is immersed a little below the surface; but with saponine the viscosity is greatest when the disc is not wholly but only partially immersed below the surface.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 14, April 2, 1883.

This number is taken up with the awards of the prizes which are yearly given by the Academy.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 2.

Distribution of Ammonia in the Air and in Atmospheric Waters at Great Elevations.—A. Müntz and F. Aubin.—Already noticed under *Comptes Rendus*, xcv., p. 788.

Temperature at the Surface of the Soil and in the Earth down to a Depth of 36 metres, also on the Comparative Temeprature of Bare and of Grass-grown Soils.—E. and H. Becquerel.—Noticed under *Comptes Rendus*, xciv., p. 1147.

Purification of Polluted Waters.—Prof. J. König.—The author proposes to purify town sewage and the waste-waters of slaughter houses, dye works, breweries, &c., by allowing them to trickle over a net-work of wire, thus exposing a large surface to the oxidising action of the atmosphere. He recommends that the coarser impurities should first be got rid of by means of settling tanks, and he mentions that the same result has been aimed at by allowing the water to flow over "graduation works," *i.e.*, thorns or bushes piled up in the shape of a high thin wall.

Denitrifying Ferment of Arable Soil.—MM. Gayon, Dupetit, Dehérain, and Maquenne.—Noticed under *Comptes Rendus*, xcv., 644.

Reduction of Sulphates by Algæ.—A. Etard and L. Olivier.—Noticed under *Comptes Rendus*, xcv., 846.

Behaviour of Difficultly Soluble Phosphates in Moorland Soils and with certain Feeble Solvents.—Dr. M. Fleischer.—The soil of the high moorlands appears to have a decided solvent power upon so-called insoluble phosphates. 100 parts of air-dried moor soil brought into solution 0·4317 phosphoric acid.

Experiments on the Action of Different Manures upon the Quantity and Quality of the Wheat Crop.—Prof. W. H. Jordan.—Phosphoric acid from bone-black superphosphate was found to increase the yield more than any other plant food. The addition of potassa, and especially of potassa and nitrogen, to the phosphoric acid gave an increased return of grain, and still more of straw. An increase of the nitrogen did not effect any proportionate increase of the harvest. The increase of the crop by the application of farm-yard manure was less decided than a complete dressing with artificial manures. Lime, ground limestone, and gypsum produced no effect worth mention.

Influence of the Moisture in Moor Soils upon Vegetation.—Prof. R. Heinrich.—Moor earth seems able to retain about 10 per cent of moisture so energetically that it cannot be appropriated by vegetation.

Sewage Irrigation at Osdorf near Berlin.—The result, according to the *Allgem. Zeit. für Deutsche Land-*

wirthe, is a failure. The water supersaturates the soil. Italian rye-grass is the best crop, but it must be consumed or sold green as drying is out of the question. Strawberries, raspberries, and gooseberries bear very large fruits, but they have neither sweetness nor flavour.

Moniteur Scientifique, Quesneville.
March, 1883.

Caoutchouc.—A. Lévy.—A lengthy memoir, in which the author considers the history of caoutchouc, the plants from which it is obtained, its extraction, the manufacturing processes to which it is submitted, and its commerce.

Review of Recent Researches concerning Mineral Chemistry.—These consist of papers on thorite and on the atomic weight of thorium, by M. L. V. Nilson, already noticed; on the atomic weight and the properties of uranium, by M. C. Zimmermann; and on the earths of Samarskite, by Professor Roscoe, disproving the alleged existence of philippium.

The Metallurgy of Copper.—Prof. Sterry Hunt.—From the *Journal of the American Institute of Mining Engineers.*

Steel of Dies for Coining.—C. von Ernst.—An account of certain analyses of steels used for this purpose by Prof. W. Chandler Roberts.

The Presence of Vanadium in an Ore from Leadville.—Dr. Malvern W. Iles.—The ore contains 9 per cent of vanadic oxide combined with lead.

Preparation of Carbonated Sodium and Potassium Aluminates.—These compounds are obtained by pouring slowly a solution of sodium or potassium aluminate into the solution of an alkaline bicarbonate traversed by a current of carbonic acid gas. The carbonated aluminates are insoluble in water, and are proposed to be used for obtaining salts of aluminium free from iron.

Oxygenated Water: its Industrial Uses, and its Employ in Surgery and Medicine.—Dr. P. Ebell.—The author's method of preparing oxygenated water, said to be more economical than that of Thenard, is not described. The product is recommended for bleaching hairs, feathers, silk, ivory, &c., after fatty matter has been previously removed by treatment with ammonium carbonate or benzol.

The Manufacture of the Sulphocyanides.—An account of the principal applications of the sulphocyanides. For the volumetric analysis of these salts an average sample of 3 to 5 grammes is dissolved in water, diluted to 500 c.c., and filtered, if needful. The solution is poured into a burette with a ground-glass tap. 10 c.c. of a decinormal solution of silver nitrate are measured off into a porcelain capsule, along with 1 to 2 c.c. of a solution of iron nitrate, and the sulphocyanide is allowed to flow into this mixture until a permanent red colour is obtained. This colour does not obtain as long as any silver remains in solution. Each c.c. of the silver solution represents 0·00580 gramme sulphocyanogen, or 0·00590 hydro-sulphocyanic acid. To prepare the ferric nitrate above mentioned 2 to 5 grammes of pianoforte wire are dissolved in nitric acid, evaporated in the water-bath to expel excess of acid, and made up to 100 c.c. with distilled water.

Accessory Products of the Gas Manufacture.—W. Siemens.—From Dr. Siemens's address before the British Association.

Recovery of Sulphur from Alkali Waste.—Carl Opl.—A portion of the lixivium is treated with hydrochloric acid and the hydrogen sulphide evolved serves to render fresh quantities of the calcium sulphide soluble. Another portion is left in contact with the air, and when it has absorbed a sufficient quantity of oxygen so that the sulphur acids may decompose each other, as in the processes of Mond and Schaffner, it is acidulated with hydrochloric acid, and the precipitate of sulphur is collected.

Assay of Linseed Oil.—In a small flask there are mixed equal measures of the oil, boiled or raw, and of nitric acid of sp. gr. 1·40. The mixture is shaken briskly for half a minute, and let stand for some time. When the separation of the oil and the acid is complete, the colour of the two strata is examined. If the upper layer is of a light cinnamon and the lower colourless, the sample is pure. If the upper stratum is either as above, of a deep olive, or a black, whilst the lower is straw-colour or orange, resin is present in quantities from 5 to 50 per cent, according to the intensity of the colour. If the upper layer is cinnamon-brown whilst the lower is colourless, the sample is genuine boiled oil. If the upper stratum is olive or black, and the lower of a paler or darker straw up to an orange, resin oil is present from 5 to 50 per cent.

Antiseptic Properties of Carbonic Acid.—Prof. H. Kolbe.—The author finds that beef in an atmosphere of carbonic acid may be kept for weeks without putrefaction, retaining its original flavour. Mutton behaves differently, and becomes offensive after a week. Fish, lobsters, oysters, and fruit remain fresh only a very short time. The author does not consider that the process is practically available.

Trans-caucasian Petroleum.—From the *Journal of the Society of Arts.*

Opium of Bulgaria.—A. Teegarten.—One of the samples examined contained as much as 20·73 per cent of morphine.

Composition of the Cylinders employed in Calico-Printing.—J. Depierre and Paul Spinal.—The metals best suited for printing are pure copper and alloys containing from 25 to 30 of zinc to from 75 to 70 of copper. Lead, even if present to the extent of ½ per cent, is injurious. The introduction of 1 per cent of phosphorus in brass renders the grain more homogeneous.

New Process of Manufacturing Aluminium.—An account of the Webster process, taken from the *Pall Mall Gazette.*

The Medicinal Oleates.—Dr. Squibb.—This paper is rather medical than chemical in its character.

An Investigation on the Sophistication of Quinine Sulphate supplied to the Hospitals.—Cinchonine appears to have been extensively substituted for quinine in a large quantity of the drug supplied to the Paris hospitals.

Gallocyanines.—Horace Kœchlin.—Inserted in full.

The Industrial Society of Mulhouse.—Session of the Chemical Committee, January 10, 1883.—M. Albert Scheurer demonstrated that zinc and magnesium chlorides in sizing attack cotton very strongly. He recommends the use of calcium chloride in their stead.

M. H. Kœchlin read a note from M. Lussy on the direct fixation of antimony sulphide upon tissues by means of sodium sulphantimoniate. The sulphide thus fixed may serve either as a brown mineral colour or as a mordant for methylene blue, malachite green, magenta, &c., which may thus be fixed as firmly as by means of tannin followed by a passage through tartar emetic.

M. Camille Kœchlin exhibited alumina as transparent as glass derived from the decomposition of the tribasic acetate by spontaneous change from the liquid to the solid state. This acetate remains liquid below 10°, but above this temperature it solidifies. The salt has then lost its solubility, and is not affected by alkalies.

MM. Noelting and Collin have prepared, by the action of nitric acid upon ethyl-acetanilide in sulphuric solution, para-nitro-ethyl-acetanilide fusible at 118°.

MM. Noelting and Cohn have prepared oxyazoic compounds of the mesitylene series by causing diazoic derivatives to react upon mesitol in an alkaline solution.

Medicinal Resorcin and Pheno-resorcin.—F. Reverdin.—The physiological action of resorcin is very similar to that of phenol. It is poisonous, but on account of its great solubility and rapid elimination it is less apt to accumulate in the system. Pheno-resorcin is not a new compound, but a mere mixture of phenol and resorcin, and is used as an antiseptic.

Use of Finely-divided Lead for the Examination of Drying Oils.—A. Livache.—The lead is obtained by precipitating with slips of zinc a 10 per cent solution of lead nitrate acidulated with a few drops of nitric acid. The precipitate obtained is agitated for a few moments with distilled water, washed by decantation two or three times; thrown into a funnel plugged with glass wool, washed quickly, first with alcohol and then with ether, and dried in a vacuum over sulphuric acid. To expel traces of ether it is lastly exposed to the air in thin layers for about two hours. For the examination of an oil, 1 gramme of the lead is spread out in a rather large watch-glass, and the oil in question is allowed to fall drop by drop from a pipette drawn out to a point, placing the drops in such a manner that a space may remain between them. The lead gradually sucks up the oil, so that every fragment is coated with an excessively thin film of oil. If the oil has been added in to great quantity it forms a thick coating, which dries at the surface, and forms a solid pellicle, which protects the lower part. About 2 parts of oil at most should be used for 3 parts of lead. The watch-glass should have been first tared; the lead is then weighed, and afterwards the oil added. The watch-glass is then exposed to a mean temperature and to full light, which materially aids oxidation. With drying oils the increase of weight sets in after about eighteen hours, and is generally at an end after three days, when it remains constant. With non-drying oils the weight generally does not begin to vary until after four or five days. Numerous series of experiments have shown the following numbers as the limits of the increase of weight of oils in presence of finely-divided lead:—Linseed, 14 to 15·5 per cent; nut, 7·5 to 8·5; cotton, 5 to 6; beech-nut, 4 to 5 per cent. The non-drying oils give an increase of weight from 1 to 3 per cent, and it is only after the lapse of some months that we find an increase of 4 to 5 per cent.

The Precipitation of Ferric and Aluminium Phosphate along with Calcium Sulphate.—C. Taquet.—The author dissolved 250 grammes superphosphate in dilute hydrochloric acid. He evaporated to dryness without calcination, and re-dissolved the mass in boiling water, and added to the filtrate a concentrated solution of pure and neutral potassium sulphate. An abundant precipitate of a yellowish white colour was at once produced. This precipitate was found to consist of 18 per cent ferric and aluminium phosphate, along with 80 per cent calcium sulphate. On the other hand, the author prepared some pure ferric phosphate, dissolved it in a minimum of hydrochloric acid, and added potassium sulphate. No precipitate was produced. Hence it follows that the phosphates are carried down by the calcium sulphate.

Bulletin de la Société Chimique de Paris.
No. 6, March 20, 1883.

Notice on the Atomic Weights.—A. Butlerow.—Inserted in full.

Study on the Combustion of Explosive Gaseous Mixtures.—MM. Mallard and Le Chatellier.—Already noticed.

Thermometric Measurements and the Determination of the Melting- and Boiling-Points.—J. M. Crafts.—Already noticed under back volumes of the *Comptes Rendus*.

Appearance of Nitrous Acid in the Evaporation of Water.—A. Scheurer-Kestner.—The author, referring to Mr. Warington's note on this subject, points out that the fact was put on record by Schœnbein many years ago (*Répertoire de Chimie Pure*, vol. v., p. 190, 1863).

Atomic Weight of Didymium.—P. T. Cléve.—The author obtains as a mean result Di = 142·124 ± 0·0326. This number deviates notably from the higher atomic weights obtained by many chemists, and especially from the figure 147, as found by the author in 1874, but these higher results are explained by the unsuspected presence of samarium, an element then unknown.

MEETINGS FOR THE WEEK.

MONDAY, April 30.—Medical, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
—— Society of Arts, 8. Cantor Lectures. "The Transmission of Energy," by Osborne Reynolds, F.R.S.
TUESDAY, May 1st.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 2. Annual Meeting.
WEDNESDAY, 2nd.—Society of Arts, 8. "Electricity as a Motive Power," Prof. George Forbes.
THURSDAY, 3rd.—Royal Institution, 3. "Count Rumford," by Prof. Tyndall.
—— Society of Arts, 8. "A New Process for the Separation and Recovery of the Volatile Constituents of Coal," by Mr. T. B. Lightfoot.
—— Chemical, 8. "A New Oxide of Tellurium.—Tellurium Sulphoxide.—A New Reaction of Tellurium Compounds," by E. Divers, M.D., and M. Shimose. "A Simple Modification of the Ordinary Method for Effecting the Combustion of Volatile Liquids by Glaser's Method with Open Tubes," by Mr. Watson Smith. "On Acenaphthene," by W. R. Hodgkinson, Ph.D.
FRIDAY, 4th.—Royal Institution, 8. "Weather Knowledge in 1883," by Mr. R. H. Scott, at 9.
Geologists' Association, 8.
SATURDAY, 5th.—Royal Institution, 3. "Geographical Evolution," by Mr. A. Geikie.

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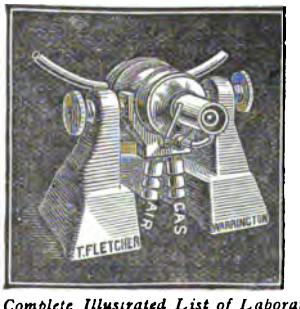

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1223.

CONTRIBUTIONS TO THE CHEMISTRY OF FOOD.*

By JAMES BELL, Ph.D., F.C.S.

THIS paper contains the results of researches on butter, cheese, milk, the cereal foods, bread, and lentil flour.

The author some time ago, as the result of a series of experiments, indicated that it was probable the soluble and insoluble fatty acids in butter-fat did not exist as simple glycerides, but in the complex form of compound ethers—palmitic and oleic acids being combined in the same molecule with butyric acid. The results of a further investigation into the character of butter-fat are given, which tend to confirm this theory of its constitution. Butter-fat is proved to vary in composition far beyond the limits previously supposed, and a table of representative samples is given, showing the ordinary variations which occur. Ordinary fats are contrasted with butter-fat, and it is suggested that the latter, from its complex character, probably performs some more specific office in the system than the former.

The proximate analyses of ten descriptions of cheese are given, and the composition of the fat extracted has been determined in each case. The soluble and insoluble fatty acids are shown to possess the normal relation existing between these acids in milk-fat, a result held to be inconsistent with the views advanced by some chemists that the albumenoids become slowly changed into fat.

Tabular results are given of a wide and comprehensive investigation into the variations which occur in the composition of the milk yielded by different cows under the varying conditions of food and season. Besides cow's milk, the proximate constituents of other kinds of milk have been determined, and as the analyses of the whole of the milks have been conducted on an uniform method, the results will be found valuable for purposes of comparison.

The changes which occur in sour milk have been investigated and the results given, with a statement of the amount of depreciation which occurs in the non-fatty solids, according to the period for which the milk has been kept.

Tabular results are given of the proximate analyses of the different cereals, of wheat-flour, and of oatmeal, and also a complete analysis of the ash of each. The proximate constituents of the cereals, &c., have been partly determined on new lines, and partly by an improved method of analysis.

Judging from the variable results obtained by different chemists, the author suggests that the saccharine matter appears in some instances to have been overlooked, while in others it must have been determined in an aqueous extract of the cereals, without regard to the transformations which the soluble albumenoids produce in starch and other carbohydrates in presence of water.

The albumenoids of the cereals have been found to possess varying degrees of diastatic action in converting starch, rye standing at the top, and rice at the bottom of the scale.

Tabular results of the proximate analyses of aërated and home-made bread are given; the changes which occur in flour during the baking process have been studied, and the sugar present identified as maltose. The results of a proximate analysis of lentil flour made on the same lines as the cereals are given, and also a complete analysis of the ash of lentils.

* Abstract of a Paper read before the Royal Society, April 26, 1883

ON ELECTRICITY APPLIED TO EXPLOSIVE PURPOSES.*

By Sir FREDERICK A. ABEL, C.B., F.R.S., Hon. M. Inst. C.E

IN introducing the subject the Lecturer indicated the principal advantages which it had been early observed would result from a certain mode of firing explosive charges by electric current instead of by the ordinary fuzes, the best of which had inherent defects, greatly limiting their use for any but the simplest operations. He traced the history and development of electric firing from the crude experiments of Benjamin Franklin, about the year 1751, through the various stages in which frictional electricity, volta-induction apparatus, and magneto-electric machines had supplied the means of generating the current, the tendency of late years being to revert to a modified form of voltaic battery for one class of work, and to employ dynamo-electric machines for another class. The history and development of the low-tension, or wire-fuze, and of the various fuzes employed with electric currents of high-tension, were also discussed, and their relative advantages, defects, and performances were described.

The only sources of electricity which at present thoroughly fulfilled the conditions essential in the exploding agent for submarine mines were constant voltaic batteries. They were simple of construction, comparatively inexpensive, required but little skill or labour in their production and repair, and very little attention to keep them in constant good working-order for long periods, and their action might be made quite independent of any operation to be performed at the last moment.

When first arrangements were devised for the application of electricity in the naval service to the firing of guns and so-called outrigger-charges, the voltaic pile recommended itself for its simplicity, the readiness with which it could be put together and kept in order by sailors, and the considerable power presented and maintained by it for a number of hours. Different forms of pile were devised at Woolwich for boat- and ship-use, the latter being of sufficient power to fire heavy broadsides by branch circuits, and to continue in a serviceable condition for twenty-four hours, when they could be replaced by fresh batteries, which had in the meantime been cleaned and built up by sailors.

The Daniell- and sand-batteries first used in conjunction with the high-tension fuze for submarine mining service were speedily replaced by a modification of the battery known as Walker's, which was after some time converted into a modified form of the Leclanché battery.

The importance of being able to ascertain by tests that the circuits leading to a mine, as well as the fuzes introduced into that circuit, were in proper order, very soon became manifest; and many instances were on record in the earlier days of submarine mining of the disappointing results attending the accidental disturbance of electric-firing arrangements, when proper means had not been known or provided for ascertaining whether the circuit was complete, or for localising any defect when discovered.

The testing of the Abel fuze, in which the bridge, or igniting and conducting composition, was a mixture of the copper phosphide and sulphide with potassium chlorate, was easy of accomplishment (by means of feeble currents of high tension), in proportion as the sulphide of copper predominated over the phosphide. Even the most sensitive might be thus tested with safety; but

* Abstract of a Lecture delivered before the Institution of Civil Engineers on Thursday evening, April 19th, 1883.

when the necessity for repeated testing, or even for the passing of a signal through the fuze, arose, as in a permanent system of submarine mines, the case was different, this fuze being susceptible of considerable alterations in conductivity on being frequently submitted to even very feeble test-currents, and its accidental ignition, by such comparatively powerful test- or signal-currents, as might have to be employed, became so far possible as to create an uncertainty which was most undesirable.

Hence, and also because the priming in these fuzes was liable to some chemical change detrimental to its sensitiveness, unless thoroughly protected from access of moisture, another form of high-tension fuze, specially adapted for submarine mining service, was devised at Woolwich. This, though much less sensitive than the original Abel fuze, was sufficiently so for service requirements, while it presented great superiority over the latter in stability and uniformity of electric resistance; and, though not altogether unaffected by the long-continued transmission of test-currents through them, the efficiency of the fuze was not affected thereby.

Although high-tension fuzes presented decided advantages in point of convenience and efficiency over the earlier form of platinum-wire fuze, the requirements which arose, in elaborating thoroughly efficient permanent systems of defence by submarine mines, and the demand for a battery for use in ships which would remain practically constant for long periods, caused a very careful consideration of the relative advantages of the high- and low-tension systems of firing to result in favour of the employment of wire-fuzes for these services. In addition to the disadvantages pointed out there was an element of uncertainty, or possible danger, in the employment of high-tension fuzes, which, though fully eliminated by the adoption of voltaic batteries, in place of generators of high-tension electricity, might still occasionally constitute a source of danger, namely, the possibility of high-tension fuzes being accidentally exploded by currents induced in cables, with which they were connected, during the occurrence of thunderstorms or of less violent atmospheric electrical disturbances.

Experiment, and the results obtained in military service operations, had demonstrated that if insulated wires, immersed in water, buried in the earth, or even extended on the ground, were in sufficient proximity to one another, each cable being in circuit with a high-tension fuze and the earth, the explosion of any of the fuzes by a charge from a Leyden jar, or from a dynamo-electric machine of considerable power, might be attended by the simultaneous ignition of fuzes attached to adjacent cables, which were not connected with the source of electricity, but which become sufficiently charged by the inductive action of the transmitted current. It therefore appeared very possible that insulated cables extending to land- or submarine-mines, in which high-tension fuzes were enclosed, might become charged inductively during violent atmospheric electrical disturbances to such an extent as to lead to the accidental explosion of mines with which they were connected. In a Report by Von Ebner on the defence of Venice, Pola, and Lissa, by submarine mines, in 1866, he refers to the accidental explosion of one of a group of sixteen mines during a heavy thunderstorm, as well as to the explosion of some mines, by the direct charging of the cables, through the firing station having been struck by lightning. Two instances of the accidental explosion of tension fuzes, by the direct charging of overhead wires during lightning discharges, occurred in 1873 at Woolwich.

Subsequently an electric cable was laid out at Woolwich along the river-bank below low-water mark, and a tension fuze was attached to one extremity, the other being buried. About eleven months afterwards the fuze was exploded by a charge induced in the conductor during a very heavy thunderstorm.

In consequence of such difficulties as these experienced in the special application of the high-tension fuzes to submarine purposes, the production of comparatively sensitive low-tension fuzes, of much greater uniformity of resistance than those employed in former years, was made the subject of an elaborate experimental investigation by the Lecturer. Different samples of comparatively thin wires, made from commercial platinum, showed very great variations in electrical conductivity. Very considerable differences in the amount of forging to which the metal, in the form of sponge, had been subjected, did not importantly affect either its specific gravity or its conductivity, and the fused metal had only a very slightly higher degree of conductivity than the same metal forged from the sponge. The conductivity of very fine wires could therefore be but slightly affected by physical differences in the metal, and the considerable differences in conductivity observed in different samples of platinum were therefore chiefly ascribable to variations in the degree of its purity. It appeared likely that definite alloys might furnish more uniform results than commercial platinum; experiments were therefore made with fine wires of German silver, and of the alloy of 66 of silver with 33 of platinum employed by Matthiessen for the reproduction of B. A. Standards of electrical resistance. Both were greatly superior to ordinary platinum in regard to the resistance opposed to the passage of a current; German silver was in its turn superior to the platinum-silver alloy; although the difference was only trifling in the small lengths of fine wire used in a fuze (0·25 inch), while the comparatively ready fusibility of the platinum-silver wire contributed, with other physical peculiarities of the two alloys, to reduce the fine German silver wire to about a level with it. Moreover, the latter did not resist the tendency to corrosive action exhibited by gunpowder, and other more readily explosive agents, which had to be placed in close contact with the wire-bridge in the construction of a fuze, while the platinum-silver was found to remain unaltered under corresponding conditions. Experiments having also been made with alloys of platinum with definite proportions of iridium, the metal with which it is chiefly associated, very fine wires of an alloy containing 10 per cent of iridium were eventually selected as decidedly the best materials for the production of wire-fuzes of comparatively high resistance and uniformity, this alloy being found decidedly superior in the latter respect, as well as in point of strength (and therefore of managableness in the state of very fine wire, 0·001 in. in diameter), to the platinum-silver wire. The fuzes now used in military and submarine services were made with bridges of iridio-platinum wire, containing 10 per cent of the first-named metal.

The electrical gun-tubes in the Navy were fired by means of a specially arranged Leclanché battery, and branch circuits worked to the different guns: in broadside firing it was important that the wire-bridge of any one of the gun-tubes which was first fired should be instantaneously fused on the passage of the current, so as to cut this branch out of circuit; in this respect the comparatively fusible platinum-silver alloy appeared to present an advantage,—hence the naval electrical fuzes were made with bridges of that alloy. Uniformity of electrical resistance had become a matter of such high importance in the delicate arrangements connected with the system of submarine mines, as now perfected, that the very greatest care was bestowed upon the manufacture of service electric fuzes and detonators, which were in fact made, in all their details, with almost the precision bestowed upon delicate scientific instruments, and the successful production of which involved an attention to minutiæ which would surprise a superficial observer.

One of the earliest applications of electricity to the explosion of gunpowder was the firing of guns upon proof at Woolwich by means of a Grove battery and a gun-tube, which was fired by a platinum-wire bridge, a shunt arrangement being used for directing the current successively into the distinct circuits connected with the guns to be proved. When the high-tension fuze had been devised, gun-tubes were made to which it was applied, and an ex-

ploder was arranged by Wheatstone, having a large number of shunts, so that as many as twenty-four guns might be brought into connection with the instrument, and successively fired by the depression of separate keys connected with each.

The firing of cannon, as time-signals, was an ancient practice in garrison-towns, but the regulation of the time of firing the gun, by electrical agency from a distance, appears first to have been accomplished in Edinburgh, where, since 1861, the time-gun had been fired by a mechanical arrangement, actuated by a clock, the time of which is controlled electrically by the mean time clock at the Royal Observatory on Calton Hill.

Shortly after the establishment of the Edinburgh time-gun, others were introduced at Newcastle, Sunderland, Shields, Glasgow, and Greenock. The firing of the gun was arranged for in various ways; in some instances it was effected either direct from the Observatory at Edinburgh, or from shorter distances, by means of Wheatstone's magneto-electric exploders. At present there were time-guns at West Hartlepool, Swansea, Tynemouth, Kendal, and Aldershot, which were fired electrically, either by currents direct from London, or by local batteries, which were thrown into circuit at the right moment by means of relays, controlled from St. Martin's-le-Grand.

About thirteen years ago the electrical firing of guns, especially for broadsides, was first introduced into the Navy, with the employment of the Abel high-tension gun-tube and voltaic piles. The gun-tubes then used were manufactured simply for the proof of cannon and for experimental artillery operations, and were of very simple and cheap construction. Experience proved them to be unfitted to withstand exposure to the very various climatic influences which they had to encounter in Her Majesty's ships, and in store in different parts of the world. The low-tension gun-tubes, having a bridge of very fine platinum-silver wire, surrounded by readily ignitable priming composition, was therefore adopted as much more suitable for our naval requirements.

The arrangements for broadsides or independent firing, and also for the firing of guns in turret-ships, had been very carefully and successfully elaborated in every detail, including the provision of a so-called drill or dummy electrical gun-tube, which was used for practice and re-fitted by well-instructed sailors. The firing-keys, and all other arrangements connected with electrical gun-firing, were specially designed to ensure safety and efficiency at the right moment.

The electric detonators for firing outrigger-torpedoes, or for other operations to be performed from open boats, corresponded, so far as the bridge was concerned, with the naval electric gun-tubes, and were fired with a specially-fitted Leclanché battery. These electric appliances were now distributed throughout the navy, and the men were kept, by instruction and periodical practice, well versed in their use.

The application of electricity to the explosion of submarine mines, for purposes of defence and attack, received some attention from the Russians during the Crimean War under the direction of Jacobi; thus a torpedo, arranged to be exploded electrically when coming into collision with a vessel, was discovered at Yeni-Kale, during the Kertsch expedition in 1855. Some arrangements were made by the British, at the conclusion of the war, to apply electricity to the explosion of large powder charges for the removal of sunken ships, &c., in Sebastopol and Cronstadt Harbours. In 1859, a system of submarine mines, to be fired through the agency of electricity by operators on shore, was arranged by Von Ebner for the defence of Venice, which, however, never came into practical operation. Early in 1860, Henley's large magneto-electric machine, with a supply of Abel fuses, and stout india-rubber bags, with fittings to resist water-pressure, were dispatched to China, for use in the Peiho River, but no application appeared to have been made of them. The subject of the utilisation of electricity for purposes of defence, however, did not receive systematic investigation in England or other countries until some years afterwards, when the great importance of submarine mines, as engines of war, was demonstrated by the number of ships destroyed and injured during the war in America.

The application of electricity to the explosion of submarine mines was very limited during that war, but arrangements for its extensive employment were far advanced in the hands of both the Federals and Confederates at the close of the war, men of very high qualifications, such as Captain Maury, Mr. N. J. Holmes, and Captain McEvoy, having worked arduously and successfully at the subject.

The explosion of submerged powder-charges, by mechanical contrivances, either of self-acting nature or to be set into action at desired periods, was accomplished as far back as 1583, during the siege of Antwerp, by the Duke of Parma, and from that period to 1854 mechanical devices of more or less ingenious and practicable character had been from time to time applied, to some small extent, in different countries, for the explosion of torpedoes. The Russians were the first to apply self-acting mechanical torpedoes with any prospect of success, and had the machines used for the defence of the Baltic been of larger size (they only contained 8 or 9 lbs. of gunpowder), their presence would probably have proved very disastrous to some of the English ships which came into collision with and exploded them. Various mechanical devices for effecting the explosion of torpedoes by their collision with a ship were employed by the Americans, a few of which proved very effective. But although in point of simplicity and cost, a system of defence by means of mechanical torpedoes possessed decided advantages over any extensive arrangements for exploding submarine mines by electric agency, their employment was attended by such considerable risk of accident to those at whose hands they received application that, under many circumstances which were likely to occur, they became almost as great a source of danger to friend as to foe.

The most important advantages secured by the application of electricity as an exploding agent of submarine mines were as follows:—They might be placed in position with absolute safety to the operators, and rendered active or passive at any moment from the shore; the waters which they were employed to defend were therefore never closed to friendly vessels until immediately before the approach of an enemy; they could be fixed at any depth beneath the surface (while mechanical torpedoes must be situated directly or nearly in the path of a passing ship), and they might be removed with as much safety as attended their application.

There were two distinct systems of applying electricity to the explosion of submarine mines. The most simple was that in which the explosion was made dependent upon the completion of the electric circuit by operators stationed at one or more posts of observation on shore; such a system depended, however, for efficiency, on the experience, harmonious action, and constant vigilance of the operators at the exploding—and observing—stations, and was, moreover, entirely useless at night, and in any but clear weather.

The other, which might also be used in conjunction with the foregoing, was that of self-acting mines, exploded either by collision with the ship, whereby circuit was completed through the enclosed fuze, or by the vessel striking a circuit closer, whereupon either the mine, moored at some depth beneath, was at once fired, or the necessary signal was given to the operator shore.

Continental nations had followed in our footsteps, in providing themselves with equipments for defensive purposes by submarine mines, and the Danes, Swedes, and Norwegians had pursued the subject of submarine mines with special activity and success.

In the United States the subject of the utilisation of electricity as an exploding agent for war purposes was

being actively pursued, and important improvements in exploding instruments, electric fuzes, and other appliances had been made by Smith, Farmer, Hill, Striedinger, and others already mentioned, while no individual had contributed more importantly to the development of the service of submarine explosions than General Abbot, of the United States Engineers.

Illustrations of actual results capable of being produced in warfare, by submarine operations, had hitherto been very few; but of the moral effects of submarine mines there had already been abundant illustrations. In the war carried on for six years by the Empire of Brazil and the Republic of Uruguay and the Argentine Republic of Paraguay, the latter managed, by means of submarine mines, to keep at bay, for the whole period, the Brazilian fleet of fifteen ironclads and sixty other men-of-war. In the Russo-Turkish war, submarine mines and torpedoes were a source of continued apprehension; and the French naval superiority was paralysed, during the Franco-German war, by the existence, or reputed existence, of mines in the Elbe.

The application of electricity to the explosion of military mines, and to the demolition of works and buildings, had been of great importance in recent wars in expediting and facilitating the work of the military engineer. The rapidity with which guns, carriages, &c., were disabled and destroyed by a small party of men who landed after the silencing of the forts at Alexandria, illustrated the advantages of electrical exploding arrangements, combined with the great facility afforded for rapid operations by the power possessed of developing the most violent action of gun-cotton, dynamite, &c., through the agency of a detonator.

The application of electricity to the explosion of mines for land-defences during active war was not an easy operation, inasmuch as not only the preparation of the mines, but also the concealment of electric cables and all appliances from the enemy, entailed great difficulties, unless the necessary arrangements could have been made in ample time to prevent a knowledge of them reaching the enemy.

But few words need be said to recall to the minds of Civil Engineers the facilities which the employment of electricity to explosive purposes afforded for expediting the carrying out of many kinds of works in which they were immediately interested. Electrical blasting, especially in combination with rock-boring machines, had revolutionised the operation of tunnelling and driving of galleries; and, although in ordinary mining and quarrying operations the additional cost involved in the employment of fuzes, conductors, and the exploding machine was not unfrequently a serious consideration, there were, even in those directions, many occasions when the power of firing a number of shots simultaneously was of great importance. There was little doubt, moreover, that accidents in mining and quarrying would be considerably reduced in number, if electrical blasting were more frequently employed.

The conveniences presented by electric firing arrangements, under special circumstances, were interestingly illustrated by a novel proceeding at the launch of a large screw steamer at Kinghorn, in Scotland, which was recently accomplised by placing small charges of dynamite in the wedge blocks along the sides of the keel, and exploding them in pairs, hydraulic power being applied at the moment that the last wedge was shot away.

In the deepening of harbours and rivers, and in the removal of natural or artificial submerged obstructions, the advantages of electric firing were so obvious that extended reference to them was unnecessary.

A substitute for electrical firing, which had been applied with success to the practically simultaneous firing of several charges, consisted of a simple modification of the Bickford fuze, which, instead of burning slowly, flashed rapidly into flame throughout its length, and hence had received the name of instantaneous fuze, or lightning fuze. The fuze burned at the rate of about 100 feet per second; it had the general appearance of the ordinary mining fuze, but was distinguished from the latter by a coloured external coating. Numerous lengths of this fuze were readily coupled up together, so as to form branches leading to different shot-holes, which might be ignited together, so as to fire the holes almost simultaneously. In the Navy this fuze was used as a means of firing small gun-cotton charges to be thrown by hand into boats when these engaged each other, the fuze being fired from the attacking boat by means of a small pistol, into the barrel of which the extremity was inserted.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MARCH 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

April 9th, 1883.

SIR,—We submit herewith the results of our analyses of the 217 samples of water collected during the past month, on the several days and at the times indicated, from the filtered water reservoirs of the seven London water companies taking their supply from the Thames and the Lea.

It will be observed that we have on this occasion, with a view to future comparisons, collected our samples not as usual from the mains, but from the reservoirs of the several Companies, after the water has been filtered, but before its entry into the mains.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 217 samples of water submitted to examination, the whole without exception were clear, bright, and well filtered. In respect to freedom from colour, the condition of the waters was superior to that observed for many months past.

In respect to the proportion of organic matter, as indicated by the determinations of organic carbon, it is interesting to compare the results afforded by the past month's analyses with those obtained before and during the recent period of quite exceptional river floods. Confining attention to the five Companies taking their supply exclusively from the Thames, the average amount of organic carbon during the past month was 0·152 part in 100,000 parts of water; the average during the month of October, when the influence of the floods began to be felt, being 0·158 part. The average for the four months, preceding October and the floods, was 0·117 part; while the average for the four succeeding months, when the floods were at their highest, was 0·244 part,—this last

and highest average, corresponding to less than half a grain of organic matter per gallon of water, with a maximum in any individual sample, out of the 68 averaged, falling short of three-quarters of a grain.

We have the honour to remain, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PROCESS FOR THE RECOGNITION OF HYDROCYANIC, HYDROCHLORIC, HYDRIODIC, CHLORIC, BROMIC, IODIC, HYDRO-FERROCYANIC, AND HYDRO-FERRICYANIC ACIDS.

By A. LONGI.

THE substance under examination is dissolved in water and the solution acidulated with acetic acid. If insoluble in water it is heated to a boil with sodium carbonate, and the filtrate is acidified with acetic acid. After any hydrogen sulphide present is expelled, silver nitrate is added in slight excess, and a little nitric acid. The precipitate may contain silver cyanide, chloride, bromide, iodide, bromate, iodate, ferrocyanide, and ferricyanide. In the solution may be present silver chlorate, bromate (in part), and mercuric cyanide. The liquid A is separated from the precipitate B, and examined separately.

A. In the liquid hydrogen is liberated by means of zinc and a little sulphuric acid. Silver chlorate and bromate are reduced to the corresponding chloride and bromide, and both these, along with mercuric cyanide, to metallic silver and mercury, hydrogen cyanide, chloride, and bromide being formed. When the reaction is at an end the mixture is filtered, and the filtrate is divided into three parts.

The first part is tested for cyanogen with a ferric ferrous salt.

To the second part is added silver nitrate, which separates hydrocyanic, hydrochloric, and hydrobromic acids. The precipitate is washed and digested in ammonia of sp. gr. 0·998. If the liquid filtered from the precipitate gives with nitric acid a white precipitate, insoluble in concentrated boiling nitric acid, chloric acid was present.

The third portion is tested for bromine with carbon disulphide. The presence of bromine shows that the original substance contained bromic acid.

B. The precipitate is carefully washed, and then digested in ammonia of sp. gr. 0·998. The cyanide, chloride, bromate, iodate, and ferricyanide are dissolved, but not the bromide, iodide, and ferrocyanide.

The residue is washed and treated with a solution of hydrogen sulphide to which a little hydrochloric acid has been added. It is heated to expel excess of hydrogen sulphide, and filtered.

The filtrate is tested for hydrogen ferrocyanide with a ferric-ferrous salt. Any ferrocyanide formed is filtered off, and the filtrate is tested for bromine and iodine with carbon disulphide.

The ammoniacal solution, which may contain cyanide, chloride, bromate, iodate, and ferricyanide, is treated with sulphurous anhydride. Cyanide and chloride are separated out; bromate, iodate, and ferricyanide are reduced to bromide, iodide, and ferrocyanide, and thrown down as such. The precipitate is washed by decantation and digested in ammonia. The cyanide and chloride are re-dissolved, but not the bromide, iodide, and ferrocyanide. The mixture is filtered. The solid matter is tested for bromine, iodine, and hydrogen ferrocyanide as above directed. Their presence shows that the original substance contained bromic and iodic acids and hydrogen ferricyanide.

To the liquid is added nitric acid, by which cyanide and chloride are re-precipitated. The precipitate is divided into two parts. The one is treated with a little dilute hydrochloric acid, and filtered. The filtrate is tested for hydrogen cyanide with a ferric-ferrous salt. The other portion is heated to a boil with concentrated nitric acid. Cyanide is thus converted into nitrate, whilst chloride remains unchanged.—*Gazzetta Chimica.*

ON THE ELECTROLYTIC BEHAVIOUR OF THALLIUM, INDIUM, VANADIUM, PALLADIUM, MOLYBDENUM, SELENIUM, AND TELLURIUM.

By L. SCHUCHT.

THALLIUM is not deposited under the influence of the current from a solution of the sulphate or nitrate containing free acid. The precipitation from a neutral solution is also incomplete in consequence of the liberation of acid.

From the ammoniacal solution of the same metal lead-grey metallic thallium is deposited at the negative electrode with a strong escape of gas, and blackish brown thallium oxide at the positive electrode. The result is the same in a solution of thallium supersaturated with potassa. From alkaline solutions the precipitation is complete.

Indium is deposited as a bluish white metal at the negative electrode, on submitting the sulphate to electrolysis. With solutions containing organic acids, indium is also deposited in a firmly adherent state, with abundant escape of gas.

On the electrolysis of vanadium chloride, dissolved in water containing hydrochloric acid, there was no precipitation. The blue colour of the solution changed to green and violet, the vanadic acid being reduced to vanadous oxide.

A watery solution of palladious nitrate, acidified with a few drops of nitric acid, gave immediately on closing the circuit a bronze-coloured deposit at the negative pole, which gradually became darker as the precipitation proceeded, and finally appeared black. At the positive pole there appeared a slight deposit of oxide of a red colour. In alkaline solutions of palladious oxide the precipitation was considerably slower, and the oxide also appeared.

From an ammoniacal solution of molybdic acid, molybdenum is deposited as molybdous oxide. Coloured rings appear first at the negative pole, which become denser and assume a deep blue-black colour. The blue deposit which first appears is a molybdic molybdate; then follow the green oxide and the black molybdous oxide. The precipitation is accompanied by an abundant escape of gas, and is perfect, as is found by testing with phosphoric acid. The deposit adheres very firmly. In acid solutions there is no precipitation, and an imperfect one from solution of ammonium molybdate containing an excess of molybdic acid.

Selenium is deposited both from acid and alkaline solutions at the negative pole, at first as a light brownish red coating, which gradually becomes thicker and darker. In both cases the precipitation is complete. As the deposit does not adhere firmly to the platinum cone, Schucht proceeds as follows: he oxidises the selenium by boiling with nitric acid, and adds the solution of some salt, the metal of which is thrown down by the current in a solid form, and thus mediates a firmly adhesive deposit of selenium. He prefers for this purpose a solution of copper. The positive pole is covered with a dark coating, which dissolves in hydrochloric acid with a yellow colour. The author ascribes this precipitation to the action of hydrogen selenide.

Tellurium behaves similarly to selenium, but is much more easily reduced by electrolysis.—*Zeitschrift f. Anal. Chemie.*

TITRATION OF IRON WITH SODIUM HYPOSULPHITE.

By A. C. OUDEMANS, Jun., and A. E. HASWELL.

The author proposes to determine iron in the acid solution of the chloride to which a little solution of copper sulphate and potassium sulphocyanide has been added, by dropping in a solution of sodium hyposulphite of known strength until the red colour of the iron sulphocyanide has disappeared, and determining the excess of hyposulphite by titrating back with iodine solution.

A. E. Haswell modifies this method so as to avoid the possibly disturbing separation of copper sulphocyanide, and to dispense with the back titration with iodine. According to his experiments the iodine-starch reaction often takes place too early, before all the hyposulphite has been converted into sodium tetrathionate. He explains this occurrence by the tendency of copper iodide to split up into cupreous iodide and free iodine, and thus produce a premature blue colouration, which after a time disappears again as the cuprous iodide re-combines with the free iodine to form the cupric iodide.

Haswell mixes the moderately acid solution of ferric chloride, in presence of a cupric salt, with a few drops of a dilute solution of sodium salicylate, and then reduces with sodium hyposulphite. The deep violet colour of the solution fades gradually and becomes colourless in presence of a very slight excess of the reducing agent. The excess of sodium hyposulphite is then oxidised with a dilute solution of sodium dichromate. The limit of the reduction is sharply marked by the faint violet colour which indicates the oxidation of a trace of the iron. It must be remembered that strong hydrochloric acid destroys the colour produced by salicylic acid in ferric chloride, which, however, is restored on moderate dilution with water.

For the execution of the method there are required—a solution of sodium hyposulphite, standardised by means of a solution of ferric chloride of known strength; a solution of potassium dichromate, about half the strength of the sodium hyposulphite; a solution of copper, prepared by dissolving 2 grammes cupric-ammonium chloride in 100 c.c. water; and a solution of sodium salicylate, containing about 5 grammes of the salt per litre.

Five or ten c.c. of the iron solution are measured into a small flask, slightly acidulated with hydrochloric acid, and mixed with 1 to 2 c.c. of the copper solution and a few drops of the sodium salicylate. If the colour resulting is not a pure violet, but of an olive-brown, the liquid is diluted with water and the hyposulphite is added until the liquid appears perfectly colourless on standing with the back to the window and looking through the flask at a sheet of white paper. It often happens that on adding more sodium salicylate a faint colouration reappears, but it is removed by a drop of hyposulphite. He then titrates back with the dichromate until a faint violet colouration appears.—*Zeitschrift f. Analytische Chemie.*

Differences of Reactional Aptitude of the Halogens in the Mixed Haloid Ethers.—L. Henry.—In a former note the author has studied the action of various reagents upon ethelenic chlorobromide. The present communication refers to ethylene chloro-iodide and bromo-iodide, which have been submitted to the same reactions as the chloro-bromide, in the midst of alcohol. He concludes that as regards reactional aptitude the difference between chlorine and bromine is greater than that between bromine and iodine.—*Comptes Rendus.*

COMMERCIAL ANALYSES.

The following letter has been sent to the leading chemists in this country. We shall be glad to receive communications on the subject, either as general comments or as particular answers to the questions.

Zurich (Switzerland), April, 1883.

Dear Sir,

The Committee of the German Society for the Promotion of Chemical Industry has resolved, upon a suggestion made by the representative of the chemical manure manufacturers, to submit to the next General Meeting of the Society the following proposal, viz.:—

> "That steps may be taken for bringing about an international agreement concerning uniform analytical methods for estimating the commercial value of certain products."

I have been honoured with the request to lay a report upon this matter before the Meeting, and for this purpose I take the liberty of addressing myself to you, to obtain the favour of your opinion thereon.

It will not be doubted that the confusion at present reigning in that matter is very awkward indeed. In the transactions between manufacturers and their buyers and sellers, unpleasant discussions or even lawsuits are frequently caused by the employment of different methods of sampling, or testing, or both—methods which must needs lead to differing results; and an appeal to a commercial analyst sometimes increases the confusion by the introduction of a third method. This would be avoided if all those concerned were agreed upon employing certain standards for sampling and testing the goods, the same specific gravity tables, and so forth.

It is, moreover, most desirable that the results of analysis should be expressed in an uniform manner. Mutual understanding is greatly impeded if, for instance, one party calculates phosphoric acid as such, the second as tricalcic phosphate, the third perhaps as monocalcic phosphate. The strength of soda-ash is expressed in a different way each in England, France, and Germany, and many other similar instances might be quoted. Not merely for commercial purposes, but also for comparing results of work, it would be most desirable to establish some such agreement. An English acid maker, who learns that his German neighbour consumes so much nitric acid at 36° Baumé for each cwt. of sulphuric acid, has no notion what that may mean in terms of 96 per cent nitrate of soda per 100 parts of sulphur, &c., &c.

A considerable portion of the German chemical manufacturers has taken steps for improving this state of affairs, at least within their own country. The chemical manure makers have agreed upon uniform and binding modes of testing, and the alkali trade is aiming at the same object by means of a "Manual for Alkali-, Potash-, and Ammonia-Works," just published. The success already attained in this direction in Germany has been an encouragement to conceive the idea that the great advantage of uniform methods might be extended internationally, and it is just the object of the present communication to gather information about the possibility of realising this.

Nobody, of course, will overlook the difficulties standing in the way of such an agreement. Some of the countries concerned do not even possess suitably organised unions of chemical manufacturers, and international unions of such a character are altogether out of the question. Even if such existed, they would never succeed in *compelling* their members to employ certain methods, or even the same way of expressing the results, and still less would they be able to exert such a compulsion upon the buying and selling public and the commercial analysts. Nor can it be denied that great differences of opinion exist as to the value of many analytical methods, and that constantly new, if not always better, methods come to the fore. Hence a rigid, compulsory code, binding for ever, or even

for a long period, is not to be thought of. But, on the other hand, those go too far who for this reason deny the possibility, or even the desirability, of an agreement in this respect. Even in public matters no law can be made which embodies absolute truth and justice; in the long run, with changing circumstances, the best laws become unsuitable and must be changed; but nobody pretends that therefore we must do without laws altogether. Without laying too much stress upon this simile, it will be conceded that an agreement among the leading manufacturers and chemists of the great industrial countries upon the matters concerned, even though it would not either possess or claim absolute binding power, would be invested with sufficient authority to serve, in a large majority of cases, as a standard in the intercourse between buyers and sellers. It would soon become a regular practice to stipulate for those standards in contracts and sale notes, and they would be acknowledged as decisive in Courts of Law.

With this view I beg to lay the following questions before you, in the respectful hope of receiving as full an answer as possible, to be made use of, either with mention of name or otherwise, as you may wish, in my Report to the Meeting of German chemical manufacturers :—

1. Do you believe that an international agreement, concerning exact standards of *sampling* ores, raw products, and chemicals could be attained?
2. Do you believe that a similar agreement could be attained in the matter of *analytical methods*, and more particularly in which definite branches of industry?
3. Do you believe that in some definite branches of chemical industry an uniform international *way of expressing the results* could be agreed upon, and have you any specific proposals to make in this respect?
4. In case you should answer one or more of the above questions in the affirmative, what *organs* would you think suitable for establishing an international agreement?
5. Do you think that such agreements should be made for an indefinite time, or that their *revision*, evidently called for from time to time, should be from the first provided for by a periodical action of the just-mentioned organs?
6. In what *form* do you think that the results of such an agreement should be made accessible to the public?

Whatever your opinion may be upon these points, I shall consider it a special favour if you will impart it to me at your convenience, in order to make use of it in my official report.

I have the honour to be, dear Sir,
Yours most respectfully,

George Lunge, Ph.D.,
Professor of Technical Chemistry at the Federal Polytechnic School, Zurich.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, April 28th, 1883.

Prof. Clifton, President, in the Chair.

A paper "*On Colour-Sensation*," by Mr. H. R. Troop, was read by Mr. Walter Baily, Secretary. The author showed that more than three colour-sensations were consistent with the theories of Maxwell and Hemholtz, and explained that four primary separate colour-sensations, in couples, served the theory as well as three. The author gave reasons for the existence of a fifth sensation—that of white.

Mr. Stanley mentioned that his father was colour-blind to green, and saw it as a brown. He considered partial colour-blindness very common.

Mr. Lewis Wright stated that he found in optical experiments a partial colour-blindness from time to time, and between one of his eyes and the other. He recommended the study of this partial and variable blindness to colours.

Prof. Clifton stated that he had found similar variations amongst his students, and considered that one in three were unfit for delicate optical experiments.

Sir John Conroy exhibited a new photometer, which is a modification of Ritchie's; the white screens not meeting at an angle, but almost meeting, and one projecting a little beyond the other, so that the eye could see the outer side of one and a little of the inner side of the other, both visible surfaces being illuminated by the lights. The screens were enclosed in a blackened box.

Mr. Walter Browne then read a paper "*On the Causes and Consequences of Glacier Motion.*" After reviewing the various theories of glacier motion and criticising each, the author gave reasons for preferring that of Mr. Mosely, namely, expansion by heat. He showed that the regelation theory now commonly accepted appeared inadequate, inasmuch as it does not explain the state of flow at low temperatures.

Mr. Stanley pointed out that Forbes in his work on Norway gives expansion as a cause of glacier motion.

Professor Perry referred to the experiment of Mr. Bottomley—in which a wire weighted at the ends cuts its way through a block of ice—in support of the regelation theory.

Professor Guthrie described an experiment he had made of the same kind, using a copper wire and a silk cord of the same thickness equally weighted on the same block of ice. The wire cut through, but the silk did not.

Professor Ayrton explained this on the assumption that the wire conveyed heat from the air, and enabled the weighted wire to lower the temperature of the ice to the melting-point, whereas the silk could not do so without more pressure, that is, weight.

Mr. W. Coffin referred to the ice-houses of Lake Superior, where he had seen heavy iron implements lying on blocks of ice at a low temperature without sinking in. Sinking took place when the sun shone on the ice.

Professor G. Forbes said that below 40 feet in rock variations of temperature were imperceptible, and probably it was the same with ice.

Professor Macleod, Mr. G. R. Griffiths, Mr. W. Baily, and the President also took part in the discussion.

Professor Fuller then took the chair, and

Professor Clifton exhibited a new spectrometer of his design. In the spectrometer it is important that the axis round which the prism turns, and the axis round which the telescope turns, should not be inclined, and in the new instrument these axes are coincident. A single cone, turned very true, has the telescope piece, the circle, and prism plate fixed on it.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Tuesday, May 1, 1883.

Warren De la Rue, Esq., M.A., D.C.L., F.R.S., Vice-President, in the Chair.

The Annual Report of the Committee of Visitors for the year 1882, testifying to the contiued prosperity and efficient management of the Institution, was read and adopted. The Real and Funded Property now amounts to above £85,400, entirely derived from the contributions and donations of the Members.

Thirty-five new Members paid their admission fees in 1882.

Sixty-three Lectures and twenty Evening Discourses were delivered in 1882.

The books and pamphlets presented in 1882 amounted to about 206 volumes, making, with 517 volumes (including periodicals bound) purchased by the Managers, a total of 723 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as Officers for the ensuing year:—

President—The Duke of Northumberland, D.C.L., LL.D.

Treasurer—George Busk, F.R.S.

Secretary—William Bowman, LL.D., F.R.S.

Managers—George Berkley, M.I.C.E.; Sir Frederick J. Bramwell, F.R.S.; Warren De la Rue, M.A., D.C.L., F.R.S.; Dyce Duckworth, M.D., F.R.C.P.; Edward Frankland, D.C.L., F.R.S.; Colonel James Augustus Grant, C.B., C.S.I., F.R.S.; Right Hon. the Lord Claud Hamilton, J.P.; William Huggins, D.C.L., F.R.S.; Sir Frederick Pollock, Bart., M.A.; Henry Pollock; The Hon. Rollo Russell, F.M.S.; The Marquis of Salisbury, K.G., M.A., F.R.S.; Sir William Siemens, D.C.L., LL.D., F.R.S.; William Spottiswoode, M.A.. D.C.L., Pres. R.S.; Sir T. Spencer Wells, Bart., Hon. F.R.C.S. Eng.

Visitors.—John Birkett, F.L.S., F.R.C.S.; The Lord Brabazon; Charles James Busk; Arthur Herbert Church, M.A., F.C.S.; Frank Crisp, LL.B., B.A., F.L.S.; Henry Herbert Stephen Croft, M.A.; William Crookes, F.R.S.; George Howard Darwin, M.A., F.R.S.; Rear-Admiral Herbert De Kantzow, R.N.; Clinton T. Dent, F.R.C.S.; Rev. John Macnaught, M.A.; Sir Charles Henry Mills, Bart., M.P.; Hugo W. Müller, Ph.D., F.R.S.; Lachlan Mackintosh Rate, M.A.; John Bell Sedgwick, F.R.G.S.

NOTICES OF BOOKS.

Disease and Putrescent Air. By THOMAS ROWAN, Consulting Engineer. London: E. and F. N. Spon.

THAT the sanitary arrangements adopted in large towns are at the present day a disgrace to the age and to the pretensions of those so-called engineers who make such matters their speciality is a fact that cannot be denied. In the construction of many of the palatial mansions in crowded cities—such, for instance, as London—it would seem to be the motto of the architect, with regard to sanitary matters, that out of sight is out of existence, and consequently that the easiest way of hiding or getting rid of refuse is, perhaps, by being the most economical so far as first cost is concerned, also the best. In this manner things are arranged for us until some innocent occupier of a tinselled shell is suddenly awakened to the fact that his drains have been constructed in a way not fit to keep a cow-house in a wholesome condition, by the outbreak of some vile form of zymotic disease in his household. Then, at the expense of much trouble and money, these hot-beds of contagium are patched up for him in such a way that they may not, at least for a while, offend his sense of smell. That this state of matters, of such vital importance to humanity, general and special, should exist, and consequently demand the adoption of stringent means for mitigating the evil, is rapidly impressing itself on scientific men, and there are many conscientious writers and experimenters who have, and are, devoting much labour to this branch of sanitation in devising effective methods for diminishing the deleterious action that a huge network of sewers in the midst of a densely populated district necessarily has. Still, where so much empiricism exists, and when the very mention of "sewer-gas" causes consternation, quackery is of necessity sure to flourish luxuriantly.

Whatever may assist in opening the eyes of corporations, building contractors, and others to the necessity of having as perfect a system of sewerage as possible is acceptable, and with this aim we presume the pamphlet before us was written in the hope that it may be found "in some small degree to promote the cause of sanitary science."

After skimming over the subject of disease and putrescent air, the author submits a process for the ventilation of sewers by downward and upward currents of air on what he terms the "intermittent system." "The object of this system is to sub-divide the sewer into sections so as to ensure its thorough ventilation; each abstractor drawing from the inlets on either side of it, and the inlets consequently delivering air to the sewer in both directions." This plan, however feasible on paper, has yet to be tested on a working scale in order to see how far natural circumstances affect the efficiency of the method.

From the general tone of the pamphlet we judge that it is the author's opinion that the thorough ventilation of a sewer, *i.e.*, causing a current of "pure" air to pass through it, is at least one of the best preventives against contagium from this source. This may, it is true, keep us ignorant of the presence of drains so far as our sense of smell goes, by diluting or sweeping out the offensive odours, carrying with them large quantities of suspended matter in which doubtless the true seat of disease lies, but it does not seem to us that mere ventilation will diminish the risks of the householder to the influence of putrescent organic matter that would still find its way from the drains into the dwelling through the defective arrangements employed to carry the refuse to the main sewer.

OBITUARY.

CHARLES HERBERT HUTCHINSON.

WE regret to announce the death, at the early age of 24, of Mr. Charles Herbert Hutchinson. Mr. Hutchinson received his scientific education in the Laboratories of the Pharmaceutical Society, where he studied from 1874 to 1877, and afterwards in the Laboratories of Professor Fresenius, at Wiesbaden. His skilful manipulation, scrupulous neatness, and, above all, his love for scientific work, won for him the admiration and interest of his teachers. While in the laboratories of the Pharmaceutical Society, Mr. Hutchinson published, in conjunction with Mr. R. H. Davies, the results of an investigation into the "Chemical Constituents of Ivy Berries" (*Pharm. Journ.*, [3], vii., 275). Upon his return from Germany he occupied for a short time the position of Assistant-curator of the Pharmaceutical Society's Museum, in order to obtain an acquaintance with medicinal plants. At this time he made a chemical examination of the plant *Myrtus Chekan*, the results of which were published in the *Pharmaceutical Journal* ([3], ix., 653). Soon after, Mr. Hutchinson became assistant to Prof. Armstrong at the London Institution and at the City and Guilds of London Institute, in Cowper Street. In April, 1879, he was elected a Fellow of the Chemical Society, and in the year following decided to turn his attention to brewing, and with this object he studied at Burton-on-Trent, and afterwards at Strassburg, finally becoming proprietor of a brewery in Essex. Mr. Hutchinson was a prominent member of the School of Pharmacy Students Association. In 1877 and again in 1878 he occupied the position of Vice-President, and for four years fulfilled the duties of Reporter upon inorganic chemistry. His reports were always looked forward to with great interest, for he had the power, far from common, of condensing long papers, embodying the

results of important researches, into *resumés* at once lucid and concise. Many of these were published in the *Pharmaceutical Journal*, and have since been the subject of much favourable comment. The following are some of the more noteworthy:—"The Formulæ of some Inorganic Substances" (embodying the researches of Meyer, Crafts, &c., upon vapour-densities at high temperatures), *Pharm. Journ.*, x., 841, and xi., 141; "Berthelot and Ditte's Researches upon the Hydrochlorides of the Metallic Chlorides" (*Ibid.*, xi., 1053); "Soxhlet's Researches upon the Estimation of the Sugars" (*Ibid.*, xi., 720, 757); "Quantitative Electrolytic Analysis" (*Ibid.*, xii., 715). At a largely attended meeting of the School of Pharmacy Students' Association on April 26 the following resolution was moved by Dr. Senier, seconded by the Honorary Secretary, Mr. Wyndham R. Dunstan, supported by many old members of the Association, and carried unanimously:—

"That the School of Pharmacy Students' Association hears with deep sorrow of the death of Mr. Charles Herbert Hutchinson, in whom the Association loses a former Vice-President and one of its most active and distinguished members, and that the members of the Association take this opportunity of expressing their sincere sympathy with the relatives of their late fellow-worker."

All who knew Mr. Hutchinson will feel that Science has lost an able and devoted worker.

CORRESPONDENCE.

ABSTRACTS OF CHEMICAL PAPERS.

To the Editor of the Chemical News.

SIR,—In the *Journal of the Chemical Society* of this month (April, 1883), abstracts of certain papers occur, and are acknowledged to their respective sources as follows:—

(1) "Novelties in the Iron Industry," by G. J. Snelus, G. L. Bell, and J. Gyers (*Ding. Polyt. Journ.*, 246, 433 to 438, 474 to 483, and 508 to 513).

(2) "Flameless Combustion," by Th. Fletcher (*Ding. Polyt. Journ.*, 246, 293 to 295).

(3) "Estimation of Coke and Volatile Products in Coal," by R. Galloway (*Chem. Centr.*, 1882, 767).

(4) Determination of Nitrites," by E. W. Davy (*Pharm. Journ. Trans.* [3], 13, 466 to 468).

The first title refers to papers read at the recent meeting of the Iron and Steel Institute in Austria, and the papers themselves are to be found in the *Journal* of the Institute.

The second title refers to a paper by Mr. Th. Fletcher, of Warrington, first read, I believe, at the recent *conversazione* of the Society of Chemical Industry, at Owens College, but, at any rate, first read in England and printed in English journals.

The subject of the third paper is a process for determining coke and volatile matter in coal, due to Mr. R. Galloway, of Dublin, and the description first appeared in a series of articles on analysis in the *Mechanical World*, a well known newspaper devoted to engineering, and published in Manchester.

The fourth heading refers to a paper read before the Royal Irish Academy by Dr. Edmund W. Davy on April 24, 1882, and no doubt to be found in the published *Transactions* or *Proceedings* of the Academy.

It seems a little curious that so excellent and valuable a *Journal* as that of the Chemical Society should depend for its reports of English papers upon abstracts in German chemical journals. If the abstracts are worth inserting it is surely better to take them first-hand, than for the information to filter through a foreign language. The authors' ideas are easier to reproduce from his own words than from an abstract in German. Perhaps, however, by the passage, they lose their dangerous properties, as vaccine lymph is said to lose its dangerous properties by passing through a calf.

It is also easier when one wants to refer to the original to find it stated at once in the Society's *Journal*, than to have to refer, first to a German or other publication, and then back to the original. The Editor and Abstractor of the Society's *Journal* would add one more to the many services they render to chemists by keeping a sharper look out in English and Irish periodicals.—I am, &c.,

THOMAS BAYLEY.

Laboratory, 7, Broad Street, Birmingham, April 30, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 15, April 9, 1883.

Report on the Electro-magnetic Machines applied to the Transmission of Mechanical Work by M. Marcel Deprez.—A very extensive report, drawn up by a select committee. The conclusions reached are to this effect:—The results obtained by M. Deprez, conformable in all respects to the theoretical principles by which engineers ought to be guided, far exceed all that had been done before him, both in the magnitude of the work transmitted as compared with the transmitting conductor, and, still more, in the mechanical yield obtained. The machine which he has designed and carried out presents notable improvements as compared with those previously constructed for the same purpose; it would probably have led to still more advantageous results if a similar one could have been constructed to act as a recipient.

Radiation of Silver at the Moment of its Solidification.—J. Violle.—At the Congress of Electricians in 1881, the author proposed as an absolute standard of light the radiation emitted by a square centimetre of melting platinum. He has since made certain experiments with silver. Liquid silver, at a temperature higher than its melting-point, being allowed to cool, it is observed at first that the radiation decreases more or less rapidly, according to the construction of the vessel containing the melted metal. The decrease slackens, and at the moment when solidification begins along the margin of the vessel, a small increase is produced. The liquid forms then in the midst of the solidified portion a kind of pool, the shores of which gradually advance, and during all this phase of the phenomenon the radiation of the liquid part remains constant. When the solidification reaches the centre there is a slight increase, followed by a rapid decrease. Silver yields thus a fixed secondary standard, which will be very useful in all spectro-photometric measurements, where the absolute intensity of the radiations is in general of little moment.

Several Optical Apparatus destined to Control Plane Surfaces, Parallel, Perpendicular, and Oblique.—L. Laurent.—This paper cannot be usefully reproduced without the three accompanying figures.

Powerful Direct-vision Spectroscope.—Ch. V. Zenger.—A combination of a parallelopipedon and a prism of crown glass, as shown in the diagram, gives a total dispersion equivalent to that of 13 to 14 prisms of carbon disulphide of 60°, an effect which is rarely attained by the most powerful spectroscopes.

Superior Limit of the Perceptibility of Sounds.—E. Pauchon.—When the pressure of steam within the box of Cagniard-Latour's syren varies from 0·5 to 1·5 atmospheres, the limit of perceptibility corresponds to sounds,

the height of which is comprised between 48,000 and 60,000 simple vibrations. On fitting the syren with a counterplate the proportion between the pressure of the steam and the speed of rotation is constantly too great, and in the conditions of the experiment the limit of perceptibility cannot be reached, not even for the sound of 72,000 vibrations, the most acute which the author could produce.

Certain Experiments made with Dynamo-Electric Machines.—J. Pollard.—The results of the author's experiments are given in the form of a table.

Reply to M. Reynier's Observations on the Bichromate Battery.—M. Trouvé.—The author had sent a correction of his figures, but it arrived too late for insertion in the *Comptes Rendus*. The consumption of zinc for the twelve elements is 0 912 kilo.

Production of Crystalline Vanadiates in the Dry Way.—A. Ditte.—The author has obtained barium, strontium, lead, zinc, cadmium, manganese, and nickel vanadiates by utilising the decomposition of the apatites.

A Compound of Phosphoric Acid and of Silica.—P. Hautefeuille and J. Margottet.—The authors treat the silica obtained from the decomposition of silicon fluoride with water, and simply dried with meta-phosphoric acid in quiet fusion in a platinum crucible. The compound obtained consists of one molecule of each constituent. Its sp. gr. is 3·1, and it is hard enough to scratch glass.

Various Boro-Tungstates.—D. Klein.—The author has not succeeded in obtaining free boro-tungstic acid, but he has prepared the tri-barium, tri-potassium, and tri-silver salts, the sodium-barium and sodium-strontium compounds.

Difference of Reactional Aptitude of the Halogens in Mixed Halogenous Ethers.—L. Henry.—The author raises the following general question :—Given a multiple compound, containing, fixed upon a hydrocarbon residue, $C_n H_m$, radicles X, X', X'', of different natures, but functionally analogous or equivalent, and especially susceptible of being affected by one and the same foreign agent Y, in what proportion and in what successive order will these different radicles be attacked by the action of this foreign agent if presented in quantity insufficient to determine a total reaction, *i.e.*, to attack all the radicles indiscriminately and each of them completely? In answering this question he has first turned his attention to the ethelenic derivatives—

$$\begin{matrix} CH_2Cl \\ | \\ CH_2Br \end{matrix}$$

and the corresponding chloro-iodic and bromo-iodic compounds. He finds from his experiments that metallic reagents manifest an exclusive, or almost exclusive, preference for bromine in presence of ethylene chlorobromide.

MISCELLANEOUS.

Volatile Constituents of Coal.—On the evening of Thursday, April 26th, an interesting and important paper was read at the Society of Arts, on "A New Process for the Separation and Recovery of the Volatile Constituents of Coal," by Mr. T. B. Lightfoot, M. Inst. C.E., the chair being occupied by Sir Henry Hussey Vivian, Bart., M.P., F.G.S. The author, after pointing out the necessity that exists for some simple and economical method for recovering volatile products now almost universally lost in the coking of coal, and showing that in the pig-iron manufacture alone the money value of this waste amounts to about 5s. 6d. per ton of iron produced, proceeded to describe the process just recently invented and brought into use by Mr. J. Jameson, of Newcastle-on-Tyne. Though recovery ovens have been before coke-makers for some time, they had not met with any great degree of favour in this country, chiefly owing to the expense attending their adoption, existing plant being entirely inapplicable; but in Jameson's process only a slight and inexpensive alteration is required, and it could therefore be at once applied to the whole of the present ovens, which are estimated to have a capacity of dealing with 20,000,000 tons of coal a year. If this were done the value of oil and ammonia so obtained would at existing prices be worth some £3,250,000, while a large amount of good heating gas, which taken at the extremely low price of 3d. per 1000 cubic feet, would come to £2,500,000, would also be mode available. The author then drew attention to the applications of the recovered products, which, instead of blackening and defacing the surface of the country and destroying vegetation as at present, would give us solid paraffin and valuable illuminating and lubricating oils, for which we are now greatly dependent on the apparently failing supply of spring oil in America. Ammonia, also, which is much wanted for agricultural operations, as well as for many industrial purposes, would be produced in large quantities; indeed, it has been estimated from the experiments of Sir J. B. Lawes that if the ammonia from all the raw coal now burnt in this country was utilised in agriculture, we should add £50,000,000 worth of breadstuffs to our produce, With regard to the gas left after condensation of the volatile constituents, it was stated that it might be most beneficially used in gas-engines for the production of mechanical work, or electricity might be generated and conveyed for conversion into light and power. The author also thought that the gas might be most advantageously employed in manufactories for heating purposes in place of raw fuel, and also for cooking and heating in domestic houses. In conclusion, attention was drawn to the desirability, both on economic and sanitary grounds, of entirely doing away with raw coal as fuel, which could only be looked on as a relic of barbarism; and tables were given showing the saving that might be realised by the proper use of gaseous fuel and coke after the recovery of the more easily condensible constituents.

MEETINGS FOR THE WEEK.

MONDAY, May 7.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "On Secondary Batteries, by Mr. C. T. Kingzett.
—— Society of Arts, 8. Cantor Lectures. "The Transmission of Energy," by Osborne Reynolds, F.R.S.
TUESDAY, 8th.—Institution of Civil Engineers, 8.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
WEDNESDAY, 9th.—Society of Arts, 8. "English and Foreign Silver Work; with some Remarks on Hall Markings," by Wilfred Cripps, F.S.A.
—— Geological, 8.
—— Microscopical, 8.
THURSDAY, 10th.—Royal Institution, 3. "Count Rumford,' by Prof. Tyndall.
—— Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 11th.—Royal Institution, 8. "Oysters and the Oyster Question," Prof. Huxley, at 9.
—— Astronomical, 8.
—— Quekett Club, 8.
SATURDAY, 12th.—Royal Institution, 3. "Geographical Evolution," by Mr. A. Geikie.
—— Physical, 3. "Measurement of Radiant Energy," by Capt. Abney, F.R.S. "An Experiment illustrating Motion Produced by Diffusion," by C. J. Woodward. "A Complete Determination of a Double Convex Lens by Measurements on the Optical Bench," by Prof. Clifton, F.R.S.

THE LONDON HOSPITAL and MEDICAL COLLEGE, Mile End, E.—The Hospital contains nearly 800 beds, and is the largest general Hospital in Great Britain. The SUMMER SESSION commenced on MAY 1ST. Students now entering can compete for the Entrance Scholarships in September. All Appointments are free to full Students. Special entries may be made for Medical and Surgical Practice, also for the Course of Practical Surgery.

MUNRO SCOTT, Warden.

THE CHEMICAL NEWS.

Vol. XLVII. No. 1224.

ON THE USE OF BROMINE IN TESTING FOR ALKALOIDS.

By C. L. BLOXAM.

If the alkaloids be dissolved in dilute hydrochloric acid, and tested with bromine water, the following reactions are observed :—

1. *Strychnine.*—A yellow precipitate, which is dissolved by boiling. If bromine water be added drop by drop, and the solution boiled between each addition, a fine violet colour is produced ; the slightest excess of bromine bleaches it, but the colour returns on boiling.

2. *Brucine.*—A violet colour in the cold, followed by a yellow precipitate on adding more bromine.

3. *Narcotine.*—A copious yellow precipitate, even in weak solutions. If bromine water be added by degrees, and the solution boiled, a rose-pink colour is obtained, easily distinguished from the violet furnished by strychnine.

4. *Quinine* behaves like narcotine, but is not so easily precipitated by bromine water. If the quinine solution, after addition of excess of bromine, be covered with weak ammonia, the characteristic green colour is seen at the plane of junction of the liquids.

5. *Morphine* is not precipitated by bromine water unless the solution be rich in morphine. If an excess of bromine water be added, the solution boiled, a piece of zinc or tin introduced, the liquid again boiled for a minute or two, cooled, and weak ammonia poured in so as to float upon the surface of the liquid, a delicate pink band of colour is seen at the plane of junction, and is diffused through the liquid on shaking the tube.

6. *Cinchonine,* in strong solutions, gives a yellow precipitate with bromine water, but no characteristic reaction.

The following process of testing has enabled me to distinguish with certainty between the above alkaloids dissolved in large excess of dilute hydrochloric acid, and presented as unknown solutions :—

To the solution of the alkaloid in hydrochloric acid—

1. Add ammonia in *slight* excess. Precipitate : cinchonine, narcotine, quinine. Dissolved in large excess : quinine.

2. Add bromine water from the end of a glass rod. Violet colour : brucine. Yellow precipitate : *probably* strychnine or narcotine. Boil, and continue to add bromine water in very small portions, boiling after each addition—Violet colour : strychnine. Rose colour : narcotine or quinine. Add bromine water in excess, and boil ; divide the solution into two parts—

(*a*) Cool, and float weak ammonia on the surface. Green colour : quinine. White precipitate : cinchonine or narcotine.

(*b*) Add a fragment of metallic zinc, boil for a minute or two, cool, and float weak ammonia on the surface. Pink colour : morphine.

Bromine water of convenient strength is made by shaking 30 drops of bromine with 8 ozs. of water.

I have not succeeded in obtaining in a pure state the fine colouring matter produced by brominating morphine and reducing with zinc or tin in hydrochloric solution. The colour is produced without addition of ammonia if the liquid be treated with excess of zinc ; it is bleached by boiling, but returns on cooling ; hydrochloric acid also bleaches it, but ammonia restores it.

King's College, London.

A LABORATORY FILTER-PRESS FOR RETAINING THE MOST FINELY-DIVIDED PRECIPITATES.

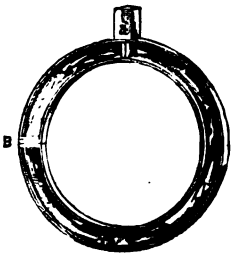
By JERVIS EYRE FOAKES.

It may be of some interest to those acquainted with the various apparatus for filtering, to learn the result of some experiments performed by a filter-press, constructed on what appears to be an entirely new principle.

With it several substances, whose nature has rendered them scarcely possible to filter by the ordinary process, have with the greatest ease been separated from the liquids in which they were suspended.

The apparatus consists of a solid flat glass ring (Fig. 1) 5 ins. in its internal, and 6 ins. in its external diameter ; thus

Fig. 1.

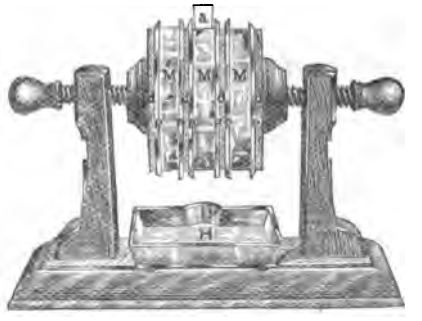


a, inlet ; B, hole for the escape of air whilst the press is filling.

leaving a surface or band of ½ in. on each side, which is ground perfectly even, and parallel to the opposite side. The breadth of the ring is generally about 1 in., but may be less, when the liquid contains little solid matter, and where the formation of a solid cake is not so much the object as quick filtration.

A diaphragm of plate glass 6 ins. in diameter, whose surface is covered by a filter-paper, or fine linen cloth, projecting about ½ in. beyond the whole circumference, is placed on each side of the ring, the flat band of the ring pressing the paper or linen against the diaphragm.

Fig. 2.



M M, glass rings ; *d d*, diaphragms ; *a*, inlet for liquid to be filtered ; P P, filter-papers.

The ring and diaphragms are then screwed tightly together in a wooden or iron stand by means of two screws having a flat disc of wood at their end. A series of rings with their corresponding diaphragms (Fig. 2) may be used instead of one ; but in this case it is necessary that 3 or 4 holes be made through each diaphragm and its covering, to allow the liquid to pass into the adjacent ring, each hole being opposite to the one in the next diaphragm.

A tube is attached to the knob (*a*, Fig. 2) to admit the liquid to the interior of the rings, which is supplied con-

tinuously whilst the press is working by a pipe leading from a sufficient height to produce the necessary pressure, the amount of this pressure varying with the elasticity and fluid state of the substance to be dealt with.

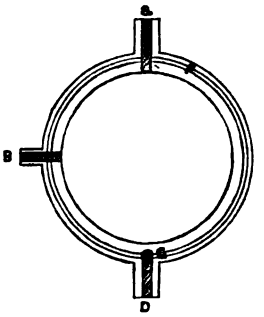
Directly pressure is applied filtration commences, all the insoluble matter being left in the hollow of the ring, or rings, whi'st the soluble contained in the filtrate passes laterally, or radially, outward along the faces of the diaphragms to the circumference, and finally escapes, running down the outside of the press into a vessel (H, Fig. 2) placed beneath to receive it.

The flow from the press depends on the number of rings, their diameter, the kind of covering placed on the diaphragm, the pressure at which the liquid is supplied, and the nature of the substance under treatment.

Filtration is produced not only along the flat band of the ring, as might be imagined, but is evenly distributed over the surface of the filtering material; for, upon examination of the paper or cloth after the press has been working for a short time, it will be noticed that there is a deposit of equal thickness over the whole surface of that part of the covering which is exposed to the liquid inside the press.

Where it is of importance that the liquid should not be exposed to the action of the air during filtration, a groove (F, Fig. 3), ¼in. in depth, is made in the flat band, and a hole (G, Fig. 3) is drilled through the rings, diaphragms, and the material with which they may be covered, connecting all the grooves in the series, with a single outlet (D, Fig. 3) at the bottom of the press.

FIG. 3.



For general use, where presses of large diameter are required, the ring is dispensed with, and its place is supplied by a buffing, or band of cotton, sewn round the edges of the diaphragms; the whole surface, including the buffing, being covered by the linen cloth. In cases of this kind the diaphragms are made of metal, or whatever material is best suited for contact with the body to be filtered.

Where large quantities of a fluid have to be passed through the press at high pressure, it is preferable to employ the direct action of steam rather than that of a force pump; for ordinary purposes a pressure from 10 lbs. to 60 lbs. to the square inch is sufficient, but this may if necessary be increased to as much as 120 lbs.

It is believed that this press has not till lately been applied to laboratory work, and it appears probable that by some slight alterations with regard to size and shape, it may become of great assistance in the collecting and washing of precipitates in quantitative analysis.

This press has been patented, and is known commercially as Bowing's filter-press.

With a small laboratory press, the following results were obtained in the laboratory of King's College. The ordinary filter papers were used, and in none of the experiments had the liquid to be passed through more than once.

I. *Barium Sulphate*—precipitated from a cold neutral solution; filtered to a clear liquid.

II. *Precipitated Sulphur* (without boiling)—filtered to a transparent liquid.

III. *Sulphide of Nickel*—prepared by precipitating nickel sulphide with excess of ammonium sulphide, producing a muddy brown liquid, which passes through an ordinary filter: filtered to a clear yellow.

IV. *Guaiacum Resin*—dissolved in alcohol, and a few drops added to a large proportion of water, yielding a milk-white solution: also filtered to a clear liquid.

V. *Faraday's Gold*—prepared by dissolving 1 grain of gold in *aqua regia*, evaporating to dryness, and adding a quart of water to the chloride obtained. On adding phosphorus dissolved in ether, and gently heating, or leaving the solution to stand for several hours, a deep colour is imparted to it. This colour has been shown to be entirely due to the presence of finely-divided gold suspended in the liquid.

If the flasks used in the preparation of this gold be carefully washed with distilled water to remove the last trace of saline matter, the liquid assumes a brilliant ruby-red colour, which may be changed to a deep purple or blue by stirring with a glass rod which has been previously dipped in a solution of common salt.

Faraday, speaking of the ruby gold, says: "The state of division of the particles must be very extreme; they have not as yet been seen by any power of the microscope."

The following coloured golds were filtered with the press to colourless liquids:—Purple, blue, and ruby-red. A portion of the last was also passed through an ordinary filter-funnel and paper ten times with hardly any perceptible alteration.

It is a remarkable fact that even with these difficult substances, should the filter-paper get torn whilst the press is in action, the filtering is in no way impaired unless the paper be damaged between the flat band of the ring and the diaphragm.

King's College Laboratory,
May 7, 1883.

METHOD FOR DETERMINING HYDROGEN CHLORIDE, BROMIDE, AND IODIDE IN SOLUTIONS CONTAINING HYDROGEN SULPHIDE.

By HALDOR TOPSÖE.

If a solution of hydrogen sulphide is gradually mixed with a moderately strong solution of potassium permanganate, previously acidified with a sufficiency of nitric acid, the liquid remains at first quite clear; a relatively small quantity of sulphur then separates out in the free state, and not until all the hydrogen sulphide is oxidised does the crimson colour of the permanganate appear. It vanishes again quickly, whilst brown manganese peroxide is deposited. The hydrogen sulphide, by the gradual addition of the oxidising agent, is converted into sulphuric acid, a comparatively small quantity of sulphur, and into traces of one of the lower oxides of sulphur, probably the hyposulphurous.

If, on the other hand, the solution of permanganate is added quickly, with stirring, and in such quantity that the liquid after the settlement of the hydrated peroxide retains a crimson colour, the hydrogen sulphide is completely oxidised to sulphuric acid. The result is unchanged if the solution of hydrogen sulphide contains hydrochloric acid or a metallic chloride, and what has already been said is in this case still applicable. If hydrobromic acid or a metallic bromide exists in the solution when the permanganate solution is continuously added, and the hydrogen sulphide entirely removed, the bromine is set at liberty. This completes the oxidation to sulphuric acid, even when not such a large excess of per-

manganate is present as is required if hydrogen sulphide is present alone or accompanied by a chloride. If hydriodic acid or a metallic iodide is present, the hydrogen sulphide is at once decomposed by the addition of the permanganate solution, which in this case must be used in a dilute state. Free sulphur is deposited, and the reaction is complete when the liquid assumes a slight yellowish brown colour from the iodine liberated.

After the hydrogen sulphide has been thus transformed or decomposed by the oxidation process, the liberated bromine or iodine may be converted into hydrogen compounds by means of aqueous sulphurous acid. In the same manner, or by means of oxalic acid, the manganese peroxide may be reduced to manganous compounds. A possible excess of sulphurous acid or oxalic acid is lastly removed by the cautious addition of a dilute solution of permanganate. The liquid contains then nothing which can interfere with the precipitation by silver nitrate.

The method thus indicated is applied as follows in the several cases:—Chlorine is determined in a liquid in which the existing hydrogen sulphide is, if possible, completely oxidised by the instantaneous addition of a large excess of permanganate, and thus converted into sulphuric acid. For every 100 c.c. of a solution of hydrogen sulphide saturated at common temperatures, at least 3·25 gramme potassium permanganate must be added along with at least 4 grammes nitric acid. But we generally have to do with a liquid from which a metallic sulphide has been precipitated by sulphuretted hydrogen, the precipitate has been filtered off, and washed. The liquid must therefore have lost a large proportion of the hydrogen sulphide with which it had been saturated. Hence the real consumption of permanganate is far smaller. The author finds by direct experiment that unless sulphuretted hydrogen water has been used for washing the precipitated sulphide, the oxidation can be completely effected by the application of 1·5 grammes permanganate per 100 c c. of the original sulphuretted solution. But if the washing has been effected with sulphuretted hydrogen water the permanganate solution is added rapidly, with constant stirring, until the liquid becomes so deeply crimson as to be opaque.

After a sufficiency of permanganate has been added (preferably dissolved in 20 to 25 parts by weight of water, with 3 to 4 parts of strong nitric acid), the liquid is let stand for a few minutes, and a solution of oxalic acid is gradually added, stirring constantly. After the greater part of the sediment has been dissolved the acid is added only drop by drop till the liquid is completely clear. To remove an excess of oxalic acid (which is not easily avoided on account of the slowness with which it acts at common temperatures upon the manganese peroxide) the liquid is heated to 35°, and a dilute solution of permanganate is added till the liquid takes a faint pink tint. A single drop of oxalic acid solution removes this slight excess of permanganate.

An aqueous solution of sulphurous acid may also be used as reducing agent instead of oxalic acid, taking the same precautions to avoid and remove excess. In this case the proportion of sulphuric acid in the liquid will naturally be greater than when oxalic acid has been used.

If the sulphur has been thus completely oxidised to sulphuric acid, precipitation with silver nitrate can be at once undertaken after the treatment with oxalic acid or with sulphurous acid. If a small proportion of sulphur has been deposited it must first be removed by filtration.

For the determination of bromine the liquid in question is quickly mixed with a strong solution of permanganate (1 part in 20 to 25 parts of water with 3 to 4 parts strong nitric acid), stirring continually, until the liquid smells of bromine. The oxidation is then complete, and the liquid after treatment with sulphurous acid can be directly precipitated with silver nitrate. The sulphurous acid is cautiously added till the sediment of manganese peroxide is re-dissolved, removing excess in the manner already laid down under chlorine.

For the determination of iodine a dilute solution of permanganate (1 part to 50 of water and 1·5 to 2 of nitric acid) is added until the liquid takes a faint brownish yellow colour from the liberation of iodine. No manganese peroxide is precipitated. The sulphur is entirely deposited in the free state, and is removed by filtration after the liquid has been decolourised by means of a few drops of aqueous sulphuric acid. The iodine is then precipitated with silver nitrate in the ordinary manner.—*Zeitschrift für Analytische Chemie.*

SPECTRAL RESEARCHES ON SCANDIUM, YTTERBIUM, ERBIUM, AND THULIUM.

By Th. THALEN.

THE emission-spectra of scandium, ytterbium, and erbium were obtained by means of a Rhumkorff, the spark of which was strengthened by the intercalation of two Leyden jars, and the electrodes were moistened with a solution of the chlorides of the metals. The most remarkable of these spectra is that of scandium. It presents a great number of lines of medium intensity in the orange and the indigo, whilst in the yellow, the green, and the blue portion there are a number of very fine but brilliant lines, forming several separate groups. The author gives the wave-lengths and intensities of different lines of the three metals in a set of tables. He has studied both the absorption- and emission-spectrum of thulium. The absorption-spectrum was examined with two solutions of nitrates, one of which was rich in erbium, and the other was almost colourless and rich in thulium. Two absorption-bands in the spectrum of thulium were distinguished by their breadth and intensity, whilst they are very faint in the erbium spectrum. The darker of the two is between the Frauenhofer's lines B and C (the middle being about $\lambda=6840$); the other is in the blue ($\lambda=4650$). In the emission-spectrum—for which again the solutions of the nitrates were employed—there are likewise two bands, one of which, broad and very brilliant, coincides with the darkest of the absorption bands. The other falls in the blue ($\lambda=4760$), and is wanting in the absorption-spectrum. There is no trace of the brilliant spectrum corresponding to the above-mentioned dark band ($\lambda=4650$), whilst it appears distinctly in the spectrum of erbium. It is hence doubtful if the absorption-band $\lambda=4650$ really belongs to thulium.—*Journal de Physique.*

ON THE SEPARATION OF MORPHINE IN CHEMICO-LEGAL INVESTIGATIONS.

By E. SCHEIBE.

THE author proposes the following method for all cases where the quantity to be separated is small:—

The comminuted portions of the body are repeatedly extracted with acidified water, urine and other liquids being previously concentrated by evaporation. The united extracts are filtered and evaporated on the water-bath almost down to the consistence of a syrup, and are then extracted with 4 to 5 volumes of alcohol at 95 per cent, and filtered. The filtrate is freed from alcohol by distillation: the residue in the retort is again filtered, and shaken up with amylic alcohol as long as colouring matter is removed. The acid liquid is then heated to 50° to 60°, an equal volume of amylic alcohol is added, the whole rendered alkaline with ammonia, and shaken up for some time. The amylic alcohol is separated from the aqueous fluid, and the shaking up is repeated with fresh portions of amylic alcohol. The extracts thus obtained are distilled, the residue evaporated to dryness, and repeatedly extracted at

a gentle heat with water slightly acidified. The acid filtrate is covered with a mixture of 10 parts anhydrous ether to 1 part of alcohol, rendered alkaline with ammonia, and shaken. This operation is repeated several times. In this manner, on the evaporation of the ethereal-alcoholic mixture the morphine is obtained free from all colouring matters which might otherwise mask the characteristic reactions.—*Chemiker Zeitung*, *Coethen*, and *Pharm. Zeit. Russlands.*

METHOD FOR DETERMINING HYDROCHLORIC, HYDROCYANIC, HYDRO-FERROCYANIC, AND SULPHOCYANIC ACIDS WHEN SIMULTANEOUSLY PRESENT.

By W. BORCHERS.

If hydrochloric, hydrocyanic, and hydro-sulphocyanic acids are present 10 to 20 grs. of the saline mixture are present, and the solution is diluted to a litre. In one portion of this liquid the total quantity of the three acids is ascertained by titration with silver solution. To another portion is added the exact quantity of the silver solution thus ascertained, and the precipitate is quickly filtered off. Washing is only required if the filtrate contains sulphates. The precipitate is not dried, but the funnel with its contents is set upon a small flask, the filter is perforated with a thin pointed glass rod, and the precipitate is washed down with nitric acid of 1·37° to 1·40° sp. gr. The contents of the flask are heated to a boil, and kept at this temperature till no more red fumes escape, adding more nitric acid if needed.

The undissolved portion of the precipitate contains all the chlorine in the form of silver chloride, which is separated by filtration. The filtrate contains silver sulphate equivalent to the sulphocyanide, and silver nitrate representing the cyanide. The sulphuric acid and the dissolved silver are therefore determined. The author finds it advisable to precipitate the sulphuric acid with barium nitrate, and to titrate the silver in the diluted filtrate partially neutralised with alkali.

The chlorine is found from the weight of the silver chloride, the sulpho-cyanogen from the sulphuric acid, and the cyanogen from the difference. The quantity of silver required to combine with the sulpho-cyanogen and cyanogen is found also by two other ways—by subtracting the quantity of silver calculated from the weighed precipitate of silver chloride from that necessary for precipitating all the acids, and, on the other hand, by direct titration of the silver dissolved by nitric acid.

If hydro-ferrocyanic acid is present along with the three others, the totality of the four acids is determined in one portion by titration with silver solution. If this is done on Volhard's method, the solution of ferric oxide used as indicator must not be added till after complete precipitation with silver solution, as otherwise a deposit of Prussian blue would take place. In a second portion the ferrocyanide is precipitated with an acid ferric salt free from chloride, the precipitate is filtered off, and the three other acids are determined as above.—*Zeitschrift für Analytische Chemie.*

Action of Sulphur upon the Alkaline Phosphates.—MM. E. Filhol and Senderens.—At ordinary temperatures finely-divided sulphur has no action upon a solution of tri- or di-potassic phosphate. If the mixture is raised to 100° there is formed a notable quantity of alkaline polysulphide and hyposulphite. If the solution is tolerably concentrated the tri-sodium phosphate is transformed into the di-sodium salt in less than two hours. The reaction tends towards the formation of a sesqui-sodium phosphate. Phosphoric acid seems to be a sesqui-basic acid, of mixed functions.—*Comptes Rendus.*

DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

Second Paper.

By Prof. J. W. MALLET, F.R.S., University of Virginia.

Origin and Character of the Research.

At the close of the report on the extended investigation of the chemical methods heretofore in use for determining organic matter in potable water,† certain suggestions were made as to possible improvements in these methods, tending to remedy defects which had been discovered in the course of the research. By direction of the Executive Committee of the National Board of Health, given during the past summer, the most important of these suggested improvements have been practically studied, and the results are now reported upon.

Combustion Process.

Evaporation of the water under much diminished pressure, in a vessel excluding contact with the atmosphere.

The vacuum vessel was a tolerably stout glass jar, such as anatomical preparations are kept in, the mouth of which had been ground flat upon a plane surface, and was covered by a disk of thick plate glass, with two bluntly tapering holes drilled through it. A strip of thick, hard, sheet brass, having two holes in it corresponding to those in the glass disk, served to form a clamp by which this disk was firmly pressed down upon a ring of sheet india-rubber laid as a washer on the ground mouth of the jar. The holes were fitted with good, soft, india-rubber stoppers, through one of which passed a funnel, with well-ground glass stopcock, and tube of almost capillary bore, while through the other passed the glass tube, serving to carry off the vapour as formed, which tube was connected with the block-tin worm, surrounded by ice-water in the worm-tub, and delivered water as condensed into the stout bottle, from which the thick india-rubber tube led to the jet-pump serving to produce exhaustion. The vacuum vessel was supported above the bottom of a large glass beaker serving as a water-bath, and this in turn was supported on a sand-bath above a Bunsen gas-burner with "rose" top.

The specimen of water to be examined was evaporated in a glass dish of about 4 inches in diameter, placed at the bottom of the vacuum vessel. At first this dish was supported in an upright position by a brass ring, and only touched the glass of the outer vessel at one point at bottom; but it was soon found that with this arrangement the transmission of heat from the water-bath was quite too slow, and hence some mercury was placed in the bottom of the vacuum vessel, and the dish was immersed in this to a considerable part of its depth. The jar was about 6 inches deep, and of a diameter just sufficient to allow the glass dish to drop down easily, but I should prefer to diminish the depth, and would indeed rather use a simple glass dish, of stout glass, with turned-over lip ground to receive directly the india-rubber washer and plate-glass cover, thus dispensing with the separate vacuum chamber altogether, and leaving but a single thickness of glass between the water-bath and the water to be evaporated. As my apparatus was arranged, no inconvenience was experienced from vapour of mercury, but in long-continued use no doubt enough of this vapour would be given off under the reduced pressure to attack the block-tin worm and make it brittle.

Owing to the slow transmission of heat at the comparatively low temperature employed, the water-bath had to be considerably warmer than the water in the dish within. The bath had immersed in it a thermometer,

* Report on the results of a supplementary investigation, made by the direction of the National Board of Health. From *American Chemical Journal*, vol. iv., No. 6.

† See CHEMICAL NEWS, vol. xlvi., p. 63

and was kept filled to the proper height by a constant-level feed. The worm-tub was filled with water at the outset, and afterwards fed with lumps of ice; an overflow tube served to carry off surplus water. If the apparatus were left at work during the night it would become necessary to supply ice-water to the condenser from a large reservoir by a constant-level feed-pipe.

It is desirable that the tubes, both of glass and of block-tin, through which the escaping vapour passes, should have an interior diameter of not less than a third of an inch.

In my experiments the water to be evaporated was introduced, about 50 c.c. at a time, by pouring into the wide portion of the funnel and very cautiously opening the stopcock. This funnel might, however, be replaced by an almost capillary tube with a glass stopcock upon it, connecting the vacuum chamber with the bottom of a flask containing the whole quantity of water to be evaporated, this flask being placed out of the reach of the heat from the lamp and water-bath: after the temperature and pressure within the apparatus have become approximately constant the stopcock might be set very partially open, so as to allow of continuous supply of more water at just the rate demanded by the progress of the evaporation. In any case the vacuum must be gradually and cautiously established at first, in order to avoid any spattering of the contents of the dish from the escape of bubbles of dissolved gases, and for the same reason each new portion of water must be introduced cautiously, not too much at a time. The stopcock on the inlet tube must be thoroughly well ground, so as to work and remain tight without any lubricant.

The vertical limb of the exit tube for the vapour should be as short as possible, to prevent any risk of liquid water condensing in it and dropping back into the dish, thus producing splashing, and with the same object in view this short vertical portion of the tube and the whole of the top of the glass covering plate are with advantage to be protected from cooling by some loose cotton-wool. The longer limb of the same exit tube should have a decided downward inclination, so as to prevent any condensed water running back.

Using mercury in the bottom of the vacuum chamber, it was heavy enough to rest steadily on its support; but if this were not the case, and there were a tendency to float up, a simple clamp could of course be used to hold the vessel firmly down.

During the greater part of my work the barometer was at something like 745 m.m., and the mercury in the jet-pump gauge stood at about 690 to 700 m.m. Entire freedom from any return of air or water through the pump, and from any abrupt oscillations of the gauge, was secured by an oiled-silk valve, opening only towards the pump, which was inserted in the line of tubing connecting the latter with the evaporation apparatus.

The temperature of the water-bath was so regulated as to keep the water in the glass dish very near, but distinctly below its boiling-point for this reduced pressure. The water was therefore evaporated at but little over 30° C., though the thermometer in the water-bath was at 55° or 60°. Of course actual boiling must not be permitted, as it would almost certainly lead to loss of water from the dish.

It was found possible to complete the evaporation of half a litre of water in this apparatus between daylight and dark on a long summer day—say within fifteen hours; but of course the rate of evaporation will depend much upon the more or less free consumption of water in running the jet-pump, so as to steadily maintain a high degree of exhaustion, and the same amount of water may be treated in less time if with higher pressure a higher temperature be permitted.

In order to test the advantage supposed to be obtainable from this method of evaporating water for the combustion process, organic matter had to be introduced in accurately known quantity, and for this purpose leucine and tyrosine were selected, as representing the more stable products of putrefaction liable to occur in natural water, and for which nevertheless the combustion process in its usual form had been found to give results far from satisfactory. Eight experiments were made with each of these substances, using from 5 to 40 m.grms. per litre of water. The results of the sixteen combustions were as follows:—

TABLE I.

	Amount obtained, as percentage on amount originally present.		
	Greatest.	Least.	Average.
Leucine:—			
Carbon	97·24	91·40.	95·77
Nitrogen	95·64	88·27	93·32
Tyrosine:—			
Carbon	98·13	92·65	97·04
Nitrogen	97·29	90·45	95·72

These figures show a marked improvement upon the results obtained with the same substances by Mr. Noyes, using the Frankland process in its usual form. There is a much nearer approach to the recovery of the quantities of carbon and nitrogen really present in the water as taken for analysis. The two elements are recovered in much more nearly the true proportion to each other. The error for each is in the same direction, that of partial loss, instead of there being a large *excess* of nitrogen. We may fairly conclude, therefore, that there is real advantage in evaporating the water at the low temperature made available by diminished pressure, and with exclusion of atmospheric air.

It is to be observed, however, that there is uniformly *some* loss, although to a comparatively small extent, so that even for analyses made under these favourable conditions it cannot be rightly claimed that the results represent the whole of the organic matter originally contained in the water. Moreover, it is probable that much of the organic matter occurring in natural waters, and it is certain that some of it, is of less stable character than the leucine and tyrosine experimented on, and for such less stable material larger losses may be expected.* And, furthermore, Frankland has found that simple evaporation with sulphurous acid, even at a temperature near 100° C., will not suffice to entirely decompose the carbonates of a natural water, but that active boiling of the water for at least a few seconds after the addition of sulphurous acid is necessary;† some injury to the organic matter may be done by such high temperature applied even for so short a time, though the mischief will probably be small. In the experiments just recorded, sulphurous acid, to the extent of about a third of the usual quantity, was added, but the water was not boiled, there being no carbonates present.

Evaporation of the water with magnesia, in order to remove ammonia existing as such or as ammoniacal salts.

Lechartier has advocated‡ the removal of ammonia by evaporation with magnesia, the determination in the residue of the nitrogen of organic matter and nitrates, a separate determination of the nitrates, and calculation of the organic nitrogen by difference. It was proposed in my general report to modify this plan by evaporating with magnesia so as to get rid of ammonia, reducing nitrates in the residue brought to a small volume, but not to dryness,—as directed by Frankland,—by addition of sulphurous acid with a drop of a solution of a ferrous salt and eva-

* It has been found by Dietzell (*Berichte d. Deutsch. Chem. Gesell.*, xv., 551) that during putrefaction very considerable quantities of free nitrogen may be evolved by the formation of nitrous acid and its reaction on leucine, primary amines, and ammonia.

† It might be worth trying whether the decomposition of carbonates could not be advantageously accomplished by some of the acid salts, such as the acid phosphate of calcium, magnesium, or sodium.

‡ *Comptes Rendus*, lxxxix., 231. *Ann. de Chim. et de Phys.*, [V.], xix., 257.

poration to dryness, and finally determining organic nitrogen only in the dry residue by combustion.

In investigating this use of magnesia, however, a difficulty was encountered which vitiates Lechartier's method as well as my proposed modification of it. He says that evaporation with magnesia at the temperature of the water-bath, while it completely expels ammonia, does not decompose organic substances, such as urea, and gives in proof of this assertion the results of some experiments, in all of which urea was the only organic substance present. This statement I am unable to verify. I have tried several forms of nitrogenous organic matter liable to occur among the products of putrefaction, and have found that at temperatures no higher than 40° to 50° C., magnesia in the presence of water slowly attacks them, evolving small amounts of ammonia, detectable by litmus-paper and paper moistened with the Nessler test solution.

The magnesia was prepared by careful ignition of pure magnesium carbonate, and was very carefully washed to free it from any possible trace of alkali. It was placed, with a few cubic centimetres of water and the organic substance to be experimented on, at the bottom of a short, wide test-tube, the mouth of which was closed by a cork, serving to suspend a strip of the moistened test-paper, and the lower part of the tube was then immersed in a water-bath kept at the required temperature.

Salts of the amines on being thus treated very naturally affected the test-paper at once, and even at common temperature.

Specimens of urea, both of natural and artificial origin, recently re-crystallised, gave the reactions of ammonia distinctly and in a very short time at 40° to 45° C. It is stated that the amic acids are not decomposed with evolution of ammonia even by boiling with solutions of the alkalies, but leucine treated as above described with magnesia at 50° C. gave the reactions of ammonia distinctly, though somewhat slowly. Tyrosine behaved in the same way; it seemed to be rather more stable.

Benzamide apparently resisted decomposition, at any rate for some minutes, at 55°, but signs of the ammonia reactions began to appear at 100°.

Hence it appears that magnesia cannot be relied upon to expel pre-existent ammonia only from an evaporated water, leaving nitrogenous organic substances untouched. The long-continued contact with the water as its dissolved contents become concentrated, even at the low temperature made available by lowering of pressure, must produce losses of organic nitrogen, which may very possibly be accompanied by loss of carbon from the same constituents.

It may, however, perhaps be the case that in waters containing relatively very large quantities of ammoniacal salts, the error due to the cause under notice would be less than that attributable to the dissociation of these salts, to an extent not accurately determinable, during the evaporation.

Reduction and removal of nitrates by evaporation of the water with hypo-phosphorous acid.

In the main report on this water-analysis investigation it was stated that some preliminary experiments made by myself had seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypo-phosphorous acid, guarding against the evolution of phosphuretted hydrogen by the low temperature employed, then adding magnesia in small excess and completing the evaporation, thus leaving the residue in a pulverulent instead of a sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypo-phosphite, and without any wrapping up of carbon particles. It was suggested that this plan was deserving of being tested.

It has now been tested, and with satisfactory results so far as the experiments have gone. Solutions of tyrosine, 20 parts per million of water, to which 10 parts of nitrogen per million had been added in the form of potassium nitrate (72·2 parts of this salt), were evaporated with 2 to 5 c.c. of a moderately strong solution of hypo-phosphorous acid. The highly concentrated, but not yet dry, residues were carefully tested for the nitrate by means of brucine, and for nitrite by Griess's naphthylamine reaction, but negative results were obtained as to both. There was no darkening or other apparent indication of the tyrosine being attacked, and on adding magnesia in excess, as proposed, to residues from the evaporation of similarly treated solutions and completing the drying, the combustion in the Sprengel vacuum was carried out without any special difficulty. In a natural water the carbonates present would be decomposed by the hypo-phosphorous acid, and carbon dioxide would be expelled during the evaporation.

In applying this method, using magnesia to neutralise the excess of acid and to dry up the residue to a condition in which it can easily be removed from the dish and mixed with cupric oxide, care must of course be taken that the magnesia is thoroughly ignited before being used, that it is not exposed to any considerable extent to the air after it has been so prepared, that the evaporation is carried on in such a vacuum chamber as has been described, and that the dried residue is not for any needless length of time exposed to the atmosphere before introduction into the combustion tube. Neglect of these precautions would lead to absorption of carbon dioxide, and consequent vitiation of the results as far as carbon is concerned. To avoid, however, the difficulty which had been ascertained to exist, arising from the action of magnesia on nitrogenous organic matter, it was thought best to use barely enough magnesia to neutralise the excess of acid, and to complete the drying up with an addition of pure *silica*, prepared by ignition of silicic acid, itself made from silicon fluoride. With this modification of the plan proposed the combustion gave results for the carbon and nitrogen of the tyrosine as good as those obtained on the average from the solutions of this substance in pure water without additions.

The solution of hypo-phosphorous acid should be carefully guarded from the air, and its strength ascertained from time to time (in order to judge approximately of the quantity to be used), not by neutralisation, but by the reducing action upon a solution of mercuric chloride.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 3, 1883.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—G. S. Bowler, A. Esilman, C. T. Heycock, H. Heap, W. J. Livingstone.

The Secretary then read a paper from Japan, "*On a New Oxide of Tellurium*," by E. Divers and M. Shimosé. When the compound of sulphur trioxide and tellurium, SO_3Te, which was prepared almost simultaneously by R. Weber and the authors of the present paper, is heated in vacuo, it decomposes between 180° and 230°, evolving sulphur dioxide, and forming a new oxide of tellurium, TeO. This oxide can be prepared in small quantity by the action of water on the sulphoxide. The oxide is black in colour with a slight brown shade, and shows, when pressed with a hard body, a graphitic lustre. It is quite stable in dry air at ordinary temperatures. Potassium hydrate has but little action upon this substance,

but it is readily decomposed by acids. No compound of TeO could be obtained, but the authors have specially compared this substance with a mixture of tellurium and tellurium dioxide, and find that its behaviour with chemical reagents is quite distinct from the reactions of the mixture.

Two papers by the same authors were also read :—

"*On Tellurium Sulphoxide.*" The authors state that they had discovered this body before the arrival of the *Berichte* and the *Chemical Society's Journal*, which contained R. Weber's account of its formation. Their results are not, in some respects, quite in accord with those obtained by the above chemist. The tellurium was obtained from the mud in the lead chambers of the Imperial Japanese Sulphuric Acid Works, in Osaka. The liquid sulphur trioxide was poured on to the tellurium, both substances being contained in a sealed glass tube. The sulphur trioxide adhering to the sulphoxide was removed by heating the latter to 35°, and exhausting with a Sprengel pump, a long tube packed with borax being interposed to absorb the trioxide. The sulphoxide is a red amorphous solid, which softens without melting at about 30°. It is vesicular in structure, and, when pure, is quite stable, at ordinary temperatures, in sealed tubes. Details of the analyses are given. When this sulphoxide is heated to 90° in a vacuum, its colour changes to a bright fawn colour. No gas is evolved, and its composition remains unaltered. The authors suggest for the red variety the constitution—

and for the brown—

Similar modifications of selenium sulphoxide seem to exist.

"*On a New Reaction of Tellurium Compounds.*" Sulphuric acid dissolves only small quantities of tellurium dioxide or its sulphate, but this solution furnishes a most delicate reaction for the presence of tellurium. By pouring some of it into a hydrogen apparatus containing zinc and dilute sulphuric acid, and passing the escaping hydrogen telluride through a second portion of the telluretted sulphuric acid, the red colour of tellurium sulphoxide is rapidly developed in the previously colourless liquid—

$$2TeH_2+TeO_2+3H_2SO_4=3SO_3Te+5H_2O.$$

Dr. Williamson was strongly impressed with the care shown by the authors in this research and with the value of their results. The existence of this protoxide raised some interesting points bearing on theoretical questions. In the first place the evidence adduced by the authors of the difference between this oxide and a mixture of tellurium and dioxide seemed to him decisive in establishing its existence, but it was curious that the authors could not prepare any corresponding compound. Now, although it has generally been required that an oxide should have its corresponding chloride, &c., as a guarantee of its existence, yet it seemed that there was no reason why an oxide should not exist without a corresponding chloride, so that the non-discovery of the chloride must not be taken as a proof that the oxide did not exist.

The Secretary then read a paper "*On a Simple Modification of the Ordinary Method for Effecting the Combustion of Volatile Liquids in Glaser's Furnace with the Open Tube,*" by Watson Smith. The author, having observed that some of the students in the Chemical Laboratory of the Owens College were not able to make presentable analyses of a sample of chemically pure benzene when using Glaser's furnace, &c., devised this modification. The end of the combustion-tube containing the liquid in a bulb is made to project from the furnace; beyond the liquid is inserted a plug of oxidised copper. This plug is warmed by a Bunsen burner, and thus the gas current is heated sufficiently to volatilise the liquid slowly and regularly. Two analyses of benzene and absolute ether are given; the results closely approximate to the theoretical numbers.

Mr. G. Beilby then read a paper "*On the Production of Ammonia from the Nitrogen of Minerals.*" In the present paper the author, who has worked at the distillation of coals and shales in connection with William Young for some years, gives the results obtained by distilling two shales—one a typical oil shale from Midlothian, the second a coal shale from Ayrshire. These shales were distilled (1) by the usual process of distilling at a low red heat; (2) at a low red heat in a current of steam; (3) at a low red heat in a current of steam, the residual coke being afterwards subjected to the prolonged action of steam at such a temperature that the whole or a large part of the carbon being consumed by the steam the nitrogen is liberated as ammonia. The soda-lime process was used for the determination of the nitrogen. The results are given in pounds of N per ton. No. 1 shale gave, with the first process, 2·70 lbs. of N as NH_3 in the watery distillate, and 1·20 lbs. in the coke. The nitrogen combined with carbon amounted to 8·88 lbs. in the coke. By using the second process, all the ammonia in the coke came over in the distillate, and 3·9 lbs. of N as NH_3 were found in the watery distillate, the N combined with carbon remaining untouched. In the third process, however, the N as NH_3 in the watery distillate amounted to 12 0 lbs.; the N combined amounted to only 0·78 lb. Similar results were obtained with No. 2 shale. In the third process, the carbon, steam, and temperature should be so adjusted that the reaction is $C+2H_2O=CO_2+2H_2$.

In reply to Dr. Armstrong, the author stated that the above improved process (No. 3) of distillation was very successful commercially, the results being startling. In one case a coal shale, which furnished only 18 lbs. of ammonium sulphate per ton, now yielded from 75 to 98 lbs. The whole of the nitrogen could not be economically obtained; much difficulty was met with in the fusion of the ash. If the coke was valuable, no one would dream of burning it away; the process was particularly useful with small and bad coal.

Mr. Beilby also read a short paper "*On the Specific Gravity of Paraffin Wax, Solid, Liquid, and in Solution.*" The specimen melted at 38° C.; its sp. gr., solid at 21°C., was 0·874; when dissolved at 21° in heavy paraffin oil, 0·7956. By taking the sp. gr. of fused samples at various temperatures, and continuing the curve thus obtained, the sp. gr. of fused paraffin at 21° would be 0·796.

The Society then adjourned to May 17, when Captain Abney will deliver a lecture on "Photographic Action Studied Spectroscopically."

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, May 7, 1883.

George Busk, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

The following Vice-Presidents for the ensuing year were announced :—Sir Frederick J. Bramwell, F.R.S.; Warren de la Rue, M.A., D.C.L., F.R.S.; Sir Frederick Pollock, Bart., M.A.; The Marquis of Salisbury, K.G., M.A., F.R.S.; Sir William Siemens, D.C.L., LL.D., F.R.S.; William Spottiswoode, M.A., D.C.L., Pres. R.S.; George Busk, F.R.S., Treasurer; William Bowman, LL.D., F.R.S., Honorary Secretary.

W. Mitchell, Miss Orbell, and Martin Ridley Smith were elected Members of the Royal Institution.

John Tyndall, D.C.L., LL.D., F.R.S., was re-elected Professor of Natural Philosophy.

Two Candidates for Membership were proposed for election.

The Presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Sound. By JOHN TYNDALL, D.C.L., LL.D., F.R.S. Fourth Edition, revised and augmented. London: Longmans and Co.

THIS book, like all that proceeds from the pen of its author, is characterised by admirable clearness. No one can profess to misunderstand its teachings. Amongst the numerous treatises on physical science it is also distinguished by its total freedom from any reference to examinations. But above all we must pronounce it valuable as being a successful attempt to expound its subject without mathematical formulæ. Any person who will take the trouble to read carefully through these nine lectures will make the "immovable truths of Acoustics" his own. A very commendable feature is the summary placed at the end of each lecture. It is, however, unnecessary to describe at length the arrangement and contents of a work which has already found such wide approval.

The principal additions to the present impression are the substance of the author's memoir on the action of free molecules upon radiant heat, and its conversion into sound; an explanation of the "soundless zones" observed by General Douane as surrounding the fog-signal stations on the coast of the United States; notices of the telephone, microphone, and phonograph, and accounts of the action upon sound of soap-bubbles filled respectively with hydrogen and nitrous oxide. The author's observations on fog-signalling have been enlarged and illustrated by means of maps, and a more complete account is given of aërial echoes where sound is thrown back, not from a solid body, but by a non-homogeneous atmosphere. The work, in short, is made complete in accordance with the most recent discoveries.

Destructive Distillation. A Manualette of the Paraffin, Coal, Tar, Rosin, Oil, and Kindred Industries. By E. J. MILLS, D.Sc., F.R.S. Second Edition. London: John Van Voorst.

WE have here a little work on a chemical subject which differs strikingly and favourably from the legion of handbooks and rudiments by which our patience is at times put to a severe test. Dr. Mills is here not reproducing matter which has been published twenty or fifty times before, and which is or should be known to every chemist or "chemistian." He is here giving information valuable not merely to students, but to manufacturers, managers, and, we hope, to intelligent workmen, and which has not been presented in a convenient and accessible form. It is no vain boast when the author says, in the Preface to his first edition, "This little book is the first to present, as a whole, the industry of destructive distillation." And though much of what is here conveyed is to be found scattered through scientific journals and transactions, there is also no little information communicated by practical men, and not hitherto published. Nor must we forget that Dr. Mills, in his capacity as "Young" Professor of Chemistry at the Anderson's College of Glasgow, has been personally engaged with researches in this important department of chemical industry.

In his Preface to the present edition the author refers to not a few capital improvements lately effected:—"The almost perfect transformation of the nitrogen of coal into ammonia and the nearly equally complete abolition of extraneous fuel in shale distilling are signal illustrations of the application of scientific skill to industry. In the laboratory the composition of many tars, both natural and artificial, has been minutely investigated, and among other results fresh evidence has been obtained of the remarkable persistence of the nC_6 group in these products. As historical facts the yield of the American oil-wells is now declining, and new sources of benzol are in imperative request." The experimentalist has here, therefore, every inducement to extend and to persist in his researches. After some ably written general considerations on destructive distillation, its products, and its principles, the author proceeds to an account of the paraffin manufacture. Thence he passes to the treatment of coal-tar, which he characterises as a "high-temperature industry" and a "dehydrogenising process," the aromatic bodies obtained containing H_n less than the corresponding fatty bodies. Coal, he remarks, is in itself less hydrogenised than the Cannel and other shales worked for paraffin. Next we have an account of wood-tar and its accompanying products. The remarkable fact is here mentioned that much of the Russian wood-tar now in the market is adulterated with brown British naphtha.

After a brief notice of apple-tar and cork-tar, and an account of the resin oils of Virginia and of the Landes, we come to petroleum. A table showing the fluctuations in its price from 1859 to August last is suggestive. In the first-mentioned year it was worth 19·77 dollars per barrel; at the last date it had sunk to 0·54 dollar. But its lowest price, 0·52 dollar, was reached in 1861. The petroleum of Baku appears to yield much more benzol, toluol, and anthracene.

An Appendix contains the bibliography of the subject in all its branches, from 1593 down to the present day. The treatise, as a whole, cannot be too strongly recommended to all persons interested in destructive distillation in any of its forms.

Notes on the Detection of the Acids (Inorganic and Organic) usually met with in Analysis, for the Use of Laboratory Students. By J. WILLIAM JAMES, Ph.D, F.C.S. London: J. and A. Churchill.

THE continued appearance of elementary treatises on chemistry, systematic or analytical, suggests a few perplexing questions. How is it that treatises covering nearly the same ground, and having no distinctive features, can always find publishers, whilst works containing the records of original study and research are vainly offered round the "Row"? Why, if students are so numerous, is the number of chemical discoveries and inventions not greater than it is found to be at present? The stream of manuals, handbooks, and the like, has been at flood for some years. But we see no proofs, so far, that it has greatly fructified the soil. Dr. James, who is demonstrator and lecturer in the Mining School, Bristol, remarks, in his Preface, that "although there are numbers of books on qualitative analysis in which the detection of the metals is ably dwelt upon, yet the acids have received but little attention, so far as their recognition when mixed is concerned." This deficiency he proposes to supply in the work before us, which extends to nineteen pages, not very closely printed. For further information on the reactions of any individual acid the reader is referred to the treatises of Fresenius and Valentin.

We do not see that the directions given are open to objection, but sundry acids, not remarkably uncommon, have been omitted. Hence, in possible cases, the student may feel perplexed.

Liquid Hydrochlorates of Terebenthene.—Ph. Barbier.—The author has examined the liquid monohydrochlorate produced by the action of hydrochloric acid upon an alcoholic solution of terebenthene, and the liquid mono-hydrochlorate obtained by the action of gaseous hydrochloric acid upon dry terebenthene.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Vol. xcvi., No. 15, April 9, 1883.

Application of the Phenomena of Supersaturation to the Theory of the Hardening of certain Cements.—H. Le Chatelier.—Not adapted for useful abstraction.

Pyro-sulphuryl Chloride. — D. Konowaloff. — The author undertakes to refute the assertion of M. Ogier (*Comptes Rendus*, March 5) that pyro-sulphuryl chloride possesses an anomalous vapour-density.

No. 16, April 16, 1883.

Combustion-heat of the Glycolates and the Law of Thermic Substitution-Constants.—A reply to the note by M. de Forcrand (*Comptes Rendus*, March 26, 1883).

Liquefaction of Oxygen and Nitrogen and Solidification of Carbon Disulphide and Alcohol.— S. Wroblewski and K. Olszewski.—Already given in full.

Researches on the Phosphates.—P. Hautefeuille and J. Margottet.—On treating the meta-phosphates with melted meta-phosphoric acid to which a progressively increasing quantity of tri-basic silver phosphate has been added, there are formed, not merely the pyro- and the ortho-phosphates, but the intermediate phosphates.

Artificial Hausmannite.—Alex. Gorgeu.—The author keeps manganese chloride for several hours in a state of fusion in an oxidising atmosphere charged with watery vapour. The product thus obtained presents the density, specific gravity, colour, and crystalline form of hausmannite.

Pyro-sulphuryl Chloride. — D. Konovaloff. — The author treats of the action of phosphoric anhydride upon sulphuric hydrochlorate, and of sulphuric anhydride upon sulphur chloride.

Researches on the Oil of Angelica of the Roots.—L. Naudin.— The author has obtained from this oil a terpene, which he names β-terebangelene, to distinguish it from the isomeric product extracted from the oil of angelica seed.

Synthesis of the Heavens and the Earth.—M. Moigno.—The author considers the ether as the original substance. A first group of atoms of ether forms hydrogen. All the other elements are formed of molecules of hydrogen in determinate number, and having their essential distribution. The molecule of each simple body is a multiple of the molecule of hydrogen. The law of Prout is a law of nature, and the divergencies found spring from errors of observation due to the difficulty of obtaining the elementary bodies in a state of absolute purity. He derives a confirmation of this idea as to the fundamental part played by hydrogen from the declaration of St. Peter and St. Clement that the heavens and the earth were formed of water.

Journal für Praktische Chemie. New Series, Vol. xxvii., Nos. 2 and 3, 1883.

Tungsten Compounds.—Dr. G. von Knorre.—There exists only one potassium tungsten bronze, $K_2W_4O_{12}$, but there are two potassium sodium tungsten bronzes, which the author has examined. The acid lithium tungstates do not yield bronzes either on electrolysis or when reduced by hydrogen. If tin is allowed to act for a short time upon a fused mixture of 5 mols. lithium oxide and 12 mols. tungstic acid, there is formed a compound which contains a little lithium. The author has examined several sodium tungstates, three of them new, but was unable to obtain the bitungstates described by Lefort. He has also examined the potassium and lithium salts. The meta-tungstates are formed when the acid tungstates are heated with water under pressure.

Diazo-Derivatives of Symmetric Tribrom-aniline.—Dr. H. Silberstein.—The author studies the action of nitrous acid upon tribrom-aniline, tribrom-diazo-benzol nitrate, the corresponding sulphate, the action of hydrochloric, hydrobromic, and hydriodic acids upon tribrom-diazo-benzol nitrate, tribrom-diazo-amido-benzol, dimethyl-amido-azo-tribrom-benzol, and methyl-phenyl-amido-azo-tribrom-benzol.

Researches on the Aluminates and Basic Haloid Salts of Barium, with Notes on Barytic Hydrate and the Haloid Salts of Barium.—Dr. Ernst Beckmann.—By the action of barium hydroxide upon an excess of aluminium hydroxide there is formed in the first place only soluble mono-barium aluminate, but on prolonged heating a small quantity of barium aluminate is formed. A soluble aluminate, composed of equal molecules of alumina and baryta, is also formed alone when alkaline mixtures are prepared from solutions of aluminium chloride and baryta water, avoiding an excess of the latter. The precipitates are hydrated alumina. Solution of baryta still attacks aluminium if a quantity of the latter equivalent to 1 mol. alumina has already entered into solution for each mol. baryta, whilst a separation of hydrated alumina, and, under certain circumstances, of insoluble barium aluminate, goes on.

The quantity of baryta present in solutions of barium aluminate can be approximately ascertained by neutralisation with an acid. The author has examined a mono-, di-, and a tri-barium aluminate, all well characterised. Of these the di-compound is distinguished by its power of crystallisation. Barytic hydrate is represented by the formula $Ba(OH)_2 8H_2O$. Eight mols. of water escape at 75°, but the last is given off only on prolonged ignition in a current of hydrogen. Dried hydrate, $Ba(OH)_2$, and anhydrous baryta, as well as the di- and tri-barium aluminates, are only attacked by carbonic acid at high temperatures. Barium dinoxide is most rapidly formed from anhydrous baryta at a cherry-red heat. Barium chloride loses more than 1 mol. of water over sulphuric acid at common temperatures, and in a current of dry air at 75° it loses all its water. Barium bromide retains its second mol. of water completely at 75°, and does not begin to lose it below 100°. Barium iodide retains its second mol. of water at 125°.

Kyanmethine.—E. von Meyer.—The object of the author is to demonstrate that the analogy between kyanmethine and kyanethine extends to their chemical behaviour.

Biuret-dicyanimide. — F. Rasinski. — A new base obtained by melting acetyl-urea with guanidine carbonate.

Behaviour of Oxy-benzoic Acid with Caustic Baryta.—A. Klepl.—These two compounds react upon each other if 2 mols. oxy-benzoic acid are heated to 350° with 7 mols. caustic baryta. Phenol is formed almost in the theoretical proportion.

Bulletin de la Société Chimique de Paris. No. 7, April 5, 1883.

Decomposition of Formic Acid by the Effluve.—L. Maquenne.—The products of the reaction are carbon dioxide, carbon monoxide, and hydrogen. There is no formation of resinous polymers.

Salts formed by Glycolic Acid.—R. de Forcrand.—Already noticed.

Action of Carbon Monoxide upon Watery Vapour.—L. Maquenne.—The oxide of carbon is, even at low temperatures, a more powerful reducing agent than hydrogen.

Swedish Correspondence: Action of Phosphorus Salt upon Various Oxides.—K. A. Wallroth.—The author has undertaken to isolate and to analyse the crystalline salts resulting from the action of phosphorus salt upon a great number of oxides. He states as a general conclusion that the atomicity of the metals exerts a very remarkable influence of the salts formed.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., February, 1883.

Report presented by M. F. Le Blanc on behalf of the Committee of Chemical Arts, on the "Intensive Burners" of the Parisian Gas Company.

Report presented by M. F. Le Blanc on behalf of the Committee of Chemical Arts on the Intensive Burners for Recovery of Heat, of M. F. Siemens, of Dresden.—These papers cannot be re-produced without the accompanying illustrations. It is further not certain that the inventions in question can legitimately be classed as chemical.

Cosmos Les Mondes.
No. 13, March 31, 1883.

Combination-Heats of the Soluble Compounds of Magnesium.—Dr. D. Tommasi.—The author gives a table of the combination-heats of certain of these compounds as calculated and as found experimentally. Another table shows the calculated heats of another series of compounds, which have not yet been experimentally verified.

The Mixed System of Domestic Lighting according to M. Trouvé.—H. Valette.—This memoir requires the six accompanying illustrations.

No. 14, April 7, 1883.

Detection of Benzoic and Boric Acids in Milk.—Dr. Meissl.—For benzoic acid, 250 to 500 c.c. of milk are rendered alkaline by means of a few drops of lime or baryta water. The liquid is then evaporated down to a quarter of its bulk, made into a paste with a little plaster, and dried in the water-bath. Sand or pumice may be employed instead of the plaster. The dry matter is finely powdered, moistened with acidulated water, and agitated with twice its volume of cold alcohol at 50 per cent. The alcoholic extract contains the benzoic acid and the salts present in the milk. The liquid is neutralised with baryta water and concentrated to a very small volume. This residue is again acidulated with sulphuric acid, and finally agitated with small quantities of ether. The ethereal extract submitted to evaporation leaves benzoic acid in a state of almost absolute purity. Boric acid is not capable of quantitative determination except present in such proportions that its weight may be deduced from the increase in the quantity of ash. The blowpipe reaction is useless, since the ash of pure milk gives a flame bordered with green. The following method is preferable:—100 c.c. are rendered alkaline with lime water, evaporated to dryness, and incinerated. The ash is dissolved in a minimum of strong hydrochloric acid, filtered over carbon, and reduced to dryness. The residue is moistened with a little weak hydrochloric acid, a little tincture of turmeric is added, and it is finally dried in the water-bath. The presence of the smallest trace of boric acid gives this residue a vermilion or cherry-red colour. Strong hydrochloric acid gives also a cherry-red with turmeric, but this colour disappears on the addition of water, and turns brown on drying.

Electro-chemical Affinities.—Dr. D. Tommasi.—The author comments on the table found on p. 177 of Professor J. D. Everett's treatise on "Physical Unities and Constants." The author there states:—"The following table contains examples of electrolytic decomposition, requiring for their production the same quantity of electricity." Upon this, Dr. Tommasi remarks: "It is quite inaccurate to say that these substances absorb in decomposition the same quantity of electricity, as they would then require for their decomposition the same quantity of heat, which, as is shown by an appended table, is not the case.

Calcination of Manganese Sulphite.—E. Maumené.—The author verifies the observations of M. Gorgeu.

No. 16, April 21, 1883.

It is announced that silk is now being used in Germany in the manufacture of cannon. A steel tube is covered round with silk thread until a sufficient tenacity is gained, and is then covered over with a stratum of gutta-percha or hardened caoutchouc to exclude moisture.

Thermo-chemistry and Electrolysis: Observations to M. Marcellin Langlois.—Dr. D. Tommasi.—The author points out the error of M. Langlois in believing that there exists no agreement between thermo-chemical data and the phenomena of electrolysis. In order that electrolysis may take place the calories produced by the battery must be at least equal to the calories absorbed by the electrolytes.

Justus Liebig's Annalen der Chemie,
Band 216, Part 3.

Boiling-Points of the Æthane and Ethylene Haloid Compounds.—A. Sabanejeff.—The differences of the boiling-points of the corresponding haloid derivatives of æthane and ethylene are constant, and vary only with the nature of the haloid, independent of its quantity. Those of the boiling-points of the chlorine compounds differ by about 30°, those of the bromine derivatives by 23°, and those of the iodide compounds by 16°.

Derivatives of Acetylene.—A. Sabanejeff.—The author treats of the preparation and properties of acetylen-dibromide, the mixed haloid compounds of acetylene, acetylene-chloro-iodide, acetylene-bromo-iodide; the action of certain reagents upon acetylene-dibromide, especially of water, of potassium carbonate and acetate, of silver acetate and nitrate, of potassium cyanide, and of phenol-potassium.

Tribrom-ethylene.—A. Sabanejeff and P. Dworkowitsch.—In tribom-ethylene only one atom of bromine can be easily replaced by the phenol residue. On further energetic reaction of the phenol-potassium, there occurs, not substitution, but oxidation, with formation of oxyphenyl-acetic acid. It is probable that intermediate products may be obtained under favourable circumstances.

Communications from the Chemical Institute of Marburg.—These consist of contributions to the knowledge of the styrol derivatives by T. Zincke, and a memoir on styrol-disulphocyanide by A. Nagel.

Tropine.—G. Merling.—The author studies the action of methyl-iodide upon tropine, methyl-tropin-platin-chloride, the corresponding gold compound; methyl-tropin, methyl-tropin-methyl-iodide, methyl-tropin-methyl-platin-iodide, the oxidation of tropine with potassium permanganate, and its conversion into tropigenine; tropigenine platinum chloride, the analogous gold compound; nitroso-tropigenine; the behaviour of tropigenine with methyl-iodide and the regeneration of tropine; the oxidation of tropine with chromic acid; tropic acid, its silver salt, and its decompositions.

Vol. 217, Part 1.

Amidoid Derivatives of Hydroxylamine: Four Metameric Benzoyl-anisyl-ethyl-hydroxylamines.—Dr. R. Pieper.—There exist four benzoyl-anisyl-ethyl-hydroxylamines sharply distinguished from each other by their chemical reactions.

Substitution-Products of the Phenol-ethers.—W. Staedel.—The author gives a summary of earlier researches in this direction, and discusses at great length the substitution-products of the phenol-ethers, certain new phenol-ethers, the nitro-cresols, the nitration of phenol-ethers, amido-cresyl-ether, and the brom-nitro- and brom-amido-anisoles and phenetoles.

Constitution of Atropine.—A. Ladenburg.—The author of this long dissertation considers his problem to be not yet solved. He shows the absolute identity of natural and artificial atropine.

Normal Paraffins.—C. Schorlemmer and T. E. Thorpe.—The authors examine the chemical behaviour of the heptan of *Pinus Sabiniana*.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 3.

Loss and Gain of Nitrogen in Arable Soils under Different Methods of Cultivation.—P. P. Dehérain.—Already noticed.

Determination of Humus in Arable Soils.—Dr. G. Loges.—The author has submitted the chromic acid process for the determination of humus in arable soils to a careful examination. He finds that the total carbon present is in no case oxidised by chromic acid, the margin fluctuating between 96 and 64 per cent. Even in soils physically and chemically identical the deficiency is not constant. The method is therefore not applicable for accurate determinations.

Influence of Organic Manures upon the Temperature of the Soil.—Dr. F. Wagner.—The author finds that the temperature of a soil is raised by the incorporation of organic manures. This rise increases, other conditions being equal, with the quantity of the manure, with the temperature of the soil (within certain limits), and with the proportion of moisture. If the temperature of the soil is below 10° the heating action of the manure is almost completely arrested. The duration of the action is from four to twelve weeks, and the average gain of temperature is from 0·10 to 0·40°. This rise of temperature is too small to have any sensible effect upon vegetation.

Determination of the Value of the Different Forms of Phosphoric Acid as determined at Poppelsdorf, 1880 and 1881.—The author is unable to draw any conclusions from his experiments.

The Application of Sparingly Soluble Phosphates on Mineral Soils.—Dr. M. Fleischer and Dr. R. Kissling.—The power of dissolving phosphates possessed by peat-mould is affected in some cases favourably and in others unfavourably by the presence of salts which may be present in manures. The most unfavourable are the alkaline hydrates and carbonates, gypsum, and calcium chloride. Soda-saltpetre and kainite have a slightly favourable action. Potassium chloride and sulphate and ammonium sulphate have the most decided influence in promoting solubility.

Preservation of Green Fodder in Silos.—Prof. G. Lechartier.—The author notices a small loss in combined nitrogen, which shows itself as ammonia. The greatest loss is in the carbo-hydrates, especially glucose and sugar. Notwithstanding this loss, which may amount to one-fifth of the total dry solids, the author considers ensilage advantageous, as the fermented mass is more digestible. (To this assertion the abstractors of the *Central-Blatt* append a query.)

Determination of the Albumenoid and Non-Albumenoid Nitrogen in Vegetables.—Dr. C. Bœhmer.—The author finds that a considerable proportion of the nitrogen in the vegetables examined—from one-fifth to nearly one-half—exists as ammonia, amidic acids, and other non-assimilable forms.

MISCELLANEOUS.

Study of the Ultra-Red Radiations by Means of the Phenomena of Phosphorescence.—In a memoir presented to the Academy (January 8, 1883), M. H. Becquerel gave a measurement of the wave-lengths of the numerous rays and bands which the phenomena of phosphorescence enable us to discern in the ultra-red solar spectrum. The same method is very simply applicable to the study of the absorption-spectra of different substances, and in particular of the telluric bands in this region of the spectrum. The absorption of the sun's light by the earth's atmosphere gives in the ultra-solar region four broad bands, the mean wave-lengths of which, expressed in millionths of a millimetre, are 930, 1082, 1230, and 1470. When the spectrum is projected upon a phosphorescent substance we may follow with much distinctness the variations of intensity and breadth presented by these bands when the sun is more or less elevated above the horizon, and the air is more or less charged with vapours. The absorption-spectrum of water is discontinuous, and presents bands which appear to coincide with the broad bands of the solar spectrum just mentioned. M. Becquerel has further studied the absorption-spectra of certain earthy metals. Through the kindness of M. Lecoq de Boisbaudran he has been able to study the ultra-red absorption-spectra of a series of products containing, in different degrees of concentration, erbium, holmium, didymium, and samarium. These substances give absorption-spectra with very remarkable bands. M. Dessains has previously observed that didymium gives cold bands in the calorific spectrum. According to the determinations made with phosphorescent substances the absorption-spectrum of didymium in the ultra-red region is characterised by three very strong bands, the wave-lengths of which are 730·5 to 756; 782 to 819; and 872 to 890. When the solution contains little didymium the bands are narrower, and their mean wave-length is 743, 796, and 872. The solutions studied show various other bands, not counting those of water; two very strong bands, with wave-lengths of about 1010 and 1180, appear to belong to samarium; two others, weaker, 840 and 910, have not been definitely traced to any substance from the want of types for comparison. Solutions free from didymium, but containing erbium and holmium, display the band 811, ascribed by M. Soret to holmium, and a fainter band, of the wave-length 890. M. Becquerel has likewise studied the absorption-spectra of various other substances. Certain solutions of copper salts arrest all the ultra-red spectrum: a solution of nickel chloride arrests the ultra-red spectrum, but lets pass that portion of the ultra-red spectrum which is not absorbed by water. A fragment of green glass lets pass merely that part of the ultra red spectrum comprised between 1150 and the least refrangible extremity. M. Becquerel has likewise studied the emission-spectra of metallic vapours.—*Comptes Rendus*, tome xcvi., No. 17.

MEETINGS FOR THE WEEK.

TUESDAY, 15th.—Institution of Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
WEDNESDAY, 16th.—Society of Arts, 8.
—— Meteorological, 7.
—— Pharmaceutical, 11. (Anniversary.)
THURSDAY, 17th.—Royal Institution, 3. "Count Rumford,' by Prof Tyndall.
—— Chemical, 8. "Photographic Action Studied Spectroscopically," by Capt. Abney, F.R.S.
FRIDAY, 18th.—Royal Institution, 3. "Domestic Industry in the Villages of Russia," by Prof. Turner, 9.
SATURDAY, 19th.—Royal Institution, 3. "Russian Social Life," by Prof. Turner.

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1225.

BÜNTE'S APPARATUS FOR DETERMINATION OF FURNACE GASES.

BY means of this apparatus a ready and sufficiently accurate separation and estimation of oxygen, hydrogen, carbonic acid, carbonic oxide, and nitrogen, may be effected in a comparatively short space of time, thereby supplying to practical men a long-felt want in the determination of furnace-gases, and enabling an operator with even a small amount of manipulative skill to ascertain the precise condition of the gaseous contents of the furnaces under his control.

Description of the Apparatus and Directions for Use.

A and B are two burettes fitted with three-way stopcocks, and each graduated in fifths of a cubic centimetre, and capable of holding about 110 c.c. ; C, a one-gallon tabulated bottle, serving as a water reservoir ; D, a suction bottle used for rarefying the gas subsequent to the introduction of reagents.

Burette A is first filled with water up to stopcock by connection with C, funnel *d* being also nearly filled. C is then disconnected from A and connection made between A and D ; the gas to be examined is now allowed to flow in at *a*, the water flowing from A to D until nearly empty. Connection is now re-established with C, and water allowed to enter until the bottom graduation is reached ; the stopcock *k* is now carefully turned in order to allow a portion of the gas (which of course is under pressure) to escape through the water in *d*, until there remains exactly 100 c.c. of gas at the normal atmospheric pressure. The apparatus is now under the proper conditions for analysis of the mixed gases.

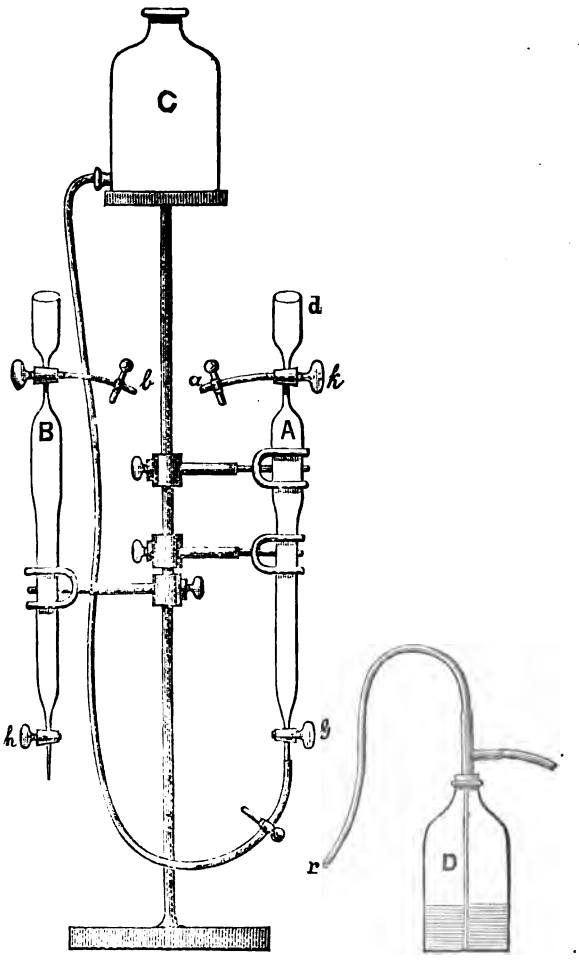
Determination of Carbonic Acid.—Tube *r* of suction bottle is connected with the bottom of the burette, suction applied at *n* and stopcock *g* turned, and all the water allowed to run out ; *g* is then closed and *r* removed ; a solution of caustic potash is now applied, and *g* being opened, a quantity of the fluid enters ; the burette is now taken from its support, the hand of the operator being placed firmly on *d*, and the gas is well shaken up with the liquid, this operation being again performed if absorption is found not to be complete. When this is effected, the stopcock at *k* is opened and water allowed to flow down until the normal atmospheric pressure is reached, indicated of course by the water ceasing to flow. The amount absorbed by the caustic potash is now read off = percentage of CO_2.

Determination of Oxygen.—The caustic potash solution is drawn off by means of the suction tube, and an alkaline solution of pyrogallic acid is applied in a similar manner as in estimation of CO_2 ; if oxygen be present the solution becomes immediately black and the diminution in volume after shaking as before, and reducing to normal pressure, gives the percentage of oxygen.

Determination of Carbonic Oxide.—If oxygen has been proved to be present, carbonic oxide will most likely be absent, unless the gases have been brought together at a temperature insufficient to promote their combination.

In order to effect the estimation of carbonic oxide by absorption it is necessary to remove every trace of the alkaline pyrogallate solution by the use of the funnel *d* and the suction bottle ; this done, a concentrated solution of cuprous chloride in hydrochloric acid is applied to the bottom of the burette as before ; when absorption is complete, the cuprous chloride is drawn off, the tube washed, and treated with a solution of caustic potash, for the purpose of absorbing any hydrochloric acid vapour which may have been liberated in the reaction ; after bringing to correct pressure, the reading shows percentage of carbonic oxide.

Carbonic oxide and hydrogen are, however, generally estimated by combustion, as follows :—The gas is allowed to mix with atmospheric air by turning the cock *k*, and momentarily releasing the pinch-tap, the water being permitted to flow out at *g* ; normal pressure is then re-established by means of the funnel *d*, and a reading taken. Connection is now made between *a* and *b*, uniting the two by means of a piece of hard glass combustion tubing containing a small coil of palladium wire. Burette B is now filled with water by connection with C. The palladium wire in the tube is brought to a red heat by means of a Bunsen burner, and the gas is caused to pass from A over the heated tube into B by opening *h* and *g*, connecting the reservoir water supply C with bottom of burette A. When all the gas has passed over the operation is reversed, the gas being again collected in A. It is allowed to stand until the normal temperature is attained, adjusted for pressure, and read off. It might perhaps be considered advisable to notice here what has taken place in the combustion. The gases remaining in the mixture are hydrogen, carbonic oxide, and nitrogen ; by the admixture of air, and passage over the red-hot palladium coil, the oxygen of the air combines with the carbonic oxide



(CO) to form carbonic anhydride (CO_2), and with the hydrogen to form water, the nitrogen of course remaining unacted upon. If the gas under examination consist entirely of hydrogen and nitrogen, it is obvious that the diminution in bulk multipled by two-thirds gives at once the percentage of the former gas; *e.g.*, supposing there to be present 10 c.c. of hydrogen, and 8 c.c. of nitrogen, and 22 c.c. of air have been admitted, the whole therefore measuring 40 c.c.; after combustion the measurement of the gas is found to be 25 c.c., showing loss in bulk of 15 c.c., which diminution is due to the combination of 10 volumes of hydrogen with oxygen 5 volumes, to form water 15 volumes (which latter occupies no appreciable space and may therefore be neglected), consequently $15 \times \frac{2}{3} = 10$ c.c. = vol. of hydrogen.

If carbonic oxide, hydrogen, and nitrogen be present, the calculation is still almost as simple. Supposing, for example, that the following mixture be contained in the burette:—

Carbonic oxide	10 c.c.
Nitrogen	12 „
Hydrogen	8 „

50 c.c. of air are admitted, the whole measuring 80 c.c.; after combustion it is found that measurement is reduced to $80 - 63 = 17$ c.c.; the 63 c.c. of gases being now submitted to the action of caustic potash solution in the usual manner, the carbonic anhydride produced in the reaction is thereby absorbed, and a further diminution of 10 c.c. observed, which indicates the percentage of carbonic oxide present, since for every volume of carbonic oxide burnt an equal volume of carbonic anhydride is formed; and since also that this 10 c.c. of CO must have consumed half its volume or 5 c.c. of oxygen, we obtain—

$$(17 - 5) \times \tfrac{2}{3} = 8 \text{ c.c. of hydrogen.}$$

Nitrogen being then calculated by difference.

ON THE DECAY OF BUILDING STONES.*

By WILLIAM WALLACE, Ph.D., F.R.S.E, F.I.C, F.C.S.

THE comparative durability of the varieties of stone suitable for building purposes is a theme of great interest to the architect; and this must plead my excuse, as a chemist, for intruding myself upon the members of a Society wholly engaged with matters connected with architecture and building construction. The most casual observation shows the most striking differences in the rocks which are brought to view by the operations of nature—some remaining firm and hard after countless ages of exposure to wind and rain, while others under similar influences have crumbled into dust. And again, an examination of the works of the architects and workmen of the old world exhibit differences not less striking. Many of the monuments of ancient Egypt and Greece show, even now, only the slightest traces of decay; while in our own country most of our cathedrals, and old churches, castles, and baronial halls have suffered great deterioration, and many of them are only saved from complete destruction by a careful system of renovation. No doubt it is scarcely fair to compare the durability of buildings in countries where rain seldom falls with those exposed to our own humid climate; but apart from this we have instances in our immediate neighbourhood which show the variations in regard to durability in different building materials exposed to the same climatic influences. While the old ecclesiastic buildings and baronial mansions, only a few centuries old, and constructed for most part of red sandstone, are mostly in ruins, with the stone ridged and furrowed, and the mouldings and carving all but obliterated, we find in the Roman Wall, stretching from the Forth to the Clyde, as seen near Kirkintilloch, blocks of whinstone from the neighbouring quarry of Auchinsterry, in which we can almost see the marks of the workmen's tools, and which are really, so far as we can see, as fit for use now as the stones just taken from the quarry. Again, in some old feudal castles, built partly of mica schist, we find pieces of that excellent, but most intractable, building material with angles as sharp as if they had just been removed from the rock.

The principal building stones employed in this country for city architecture, if we except granite, the use of which is confined to one particular town and district, and which does not lend itself kindly to the artistic aspirations of the architect, are—1. Sandstone, or as it is generally called by builders, on account of the ease with which it is wrought, freestone; 2. Limestone in its more compact form; 3. Oolitic limestone; and 4. Magnesian limestone or dolomite. In the present short paper I propose to deal only with the first of these—sandstone—as it is the only one with which we are locally interested, all our buildings being constructed of that material, which occurs in great abundance in the new red sandstone, the carboniferous, and the old red sandstone strata. It is a common matter of observation that, apparently, little care is taken in the selection of the stone, even in cases where durability is most important; and it is a fair inference that architects really do not know how to distinguish a stone that will stand well from one that will rapidly decay. Certain quarries acquire a reputation because experience has shown that the stone taken from them has stood well; but the architect or builder who selects it cannot tell in what respect it differs from another stone that is known to be bad. It is in the hope of being able to throw a little light on the subject that I have ventured to introduce it, trusting that my remarks will lead to a discussion that will bring out many points of interest.

I have to acknowledge my indebtedness to Messrs. Watt and Wilson, contractors, for kindly supplying me with twelve specimens of stone from well known quarries. Of these I have made careful chemical analyses, and the results are contained in the subjoined table (see next page), and to which I shall frequently have occasion to refer. In regard to one of them, the first on the list, from Kenmure, Bishopbriggs, Messrs. Watt and Wilson say in the letter accompanying the specimens—"This seems to be a picked bit: it is well known that there is not much good weather stone to be got in the Bishopbriggs quarries now." In a letter of more recent date, in answer to an inquiry, they say it is from a new quarry, and that the quantity obtainable is probably not large.

Let us see, in the first place, what sandstone is. Its chemical composition, as well as its physical character, shows it to consist essentially of particles of sand—in other words, crystallised or crystalline silica—formed no doubt, by the disintegration of older rocks, and washed by the action of water into beds, sometimes of great thickness, where, by the infiltration of other substances, such as lime in solution, it has gradually been consolidated until it became a firm rock. Among the mineral substances found in sandstone, in addition to the leading ingredient silica—the most important, undoubtedly, as regards the formation of a hard and durable rock—are the carbonates of lime and magnesia. So great is the effect of these bodies in filling up the intervening spaces between the particles of sand and forming a firm mass, that the durability of a stone may, with tolerable accuracy, be deduced from the proportion of these compounds found in it. In the twelve specimens I have examined in connection with this paper, the amount of these carbonates varies from 0·57 to 12·58 per cent. I have to direct your attention, however, to the Craigleith stone, which is well known to be one of the most durable of its class, but which contains the smallest quantity of carbonates—0·57 per cent. Now, this stone is one of the heaviest in the list, and it is the least porous of all; whereas

* Read before the Architectural Section of the Glasgow Philosophical Society.

ANALYSES OF TWELVE SAMPLES OF SANDSTONE OBTAINED FROM MESSRS. WATT AND WILSON, CONTRACTORS.

AIR-DRIED.

Name of Quarry	Kenmure.	Overwood.	Giffnock.	Dunmore.	Ravens-craig.	Craigleith.	Polmaise.	Polmaise.	Inverkip.	Bothwell Park.	Corsehill.	Wemyss Bay.
Colour of Stone	White.	White.	White.	White.	White.	White.	White.	Yellow.	Light pink.	Red-brown.	Red.	Red.
Silicious Matter, insol. in acid	86·26	88·86	94·94	94·48	96·99	98·29	84·14	93·20	95·76	95·28	94·32	96·67
Alumina	0·80	1·19	0·56	0·68	0·78	0·49	0·52	0·32	1·77	0·51	1·34	0·81
Peroxide of Iron	2·62	2·50	1·22	0·80	0·14	0·27	1·92	1·20	0·47	0·98	1·70	1·05
Carbonate of Lime	5·72	2·30	1·28	2·47	0·31	0·36	7·92	2·94	0·30	0·51	0·44	0·37
Carbonate of Magnesia ..	3·33	1·97	0·89	1·13	0·21	0·21	4·66	1·57	1·16	0·33	0·59	0·74
Phosphate of Lime	0·15	0·11	0·07	0·04	trace	0·04	0·08	0·03	0·05	0·04	0·11	0·09
Sulphate of Lime	0·09	0·10	0·06	0·07	0·05	0·08	trace	0·03	0·08	0·07	0·05	0·08
Loss on Ignition	0·75	0·62	1·10	0·35	1·17	0·28	0·04	0·55	0·24	—	0·33	0·26
Water at 212° F.	0·11	2·10	0·04	0·20	0·18	0·09	0·04	0·09	0·32	1·42	0·72	0·30
	99·83	99·75	100·16	100·22	99·83	100·11	99·32	99·93	100·15	99·14	99·60	100·37
Specific Gravity	2·318	2·249	2·113	2·165	2·052	2·260	2·192	2·202	2·137	2·048	2·063	2·078
Weight of a Cubic Foot, lbs.	144·4	140·1	131·7	134·9	127·9	140·8	136·6	137·2	133·2	127·6	128·6	129·5
Cubic Feet per ton	15·5	16	17	16·6	17·5	15·9	16·4	16·3	16·8	17·5	17·4	17·3
Absorption of Water, per cent	3·9	5·0	5·9	5·1	6·1	3·4	4·4	5·0	5·5	6·4	6·1	7·2
Colour after Ignition ..	Dark red-dish grey.	Reddish grey.	Grey.	Light grey.	White.	Nearly white.	Yellow grey.	Red.	Light red.	Rather dark red.	Deep red.	Deep red.
Total Carbonates	9·05	4·27	2·17	3·60	0·52	0·57	12·58	4·51	1·46	0·84	1·03	1·11

in the others the weight is directly, and the porosity inversely, proportionate to the quantity of the carbonates of the alkaline earths. The fact is that this Craigleith stone is not a true freestone or sandstone, but approaches in its nature to the "kingle" of mining engineers—a kind of quartz rock or metamorphosed sandstone of great hardness. How it is formed is probably not certainly known, but my impression is that it has become indurated by an infiltration of silica dissolved in water which has percolated through it. I understand that this stone, which is very hard, is chiefly used for the steps and landings of stairs, and very little, if at all, for general building purposes.

The alumina, the proportion of which varies from 0·32 in the yellow Polmaise stone to 1·77 in the pink coloured Inverkip stone, is probably due to the undecomposed minerals associated with the sand, and is not likely to have much influence on the strength or durability of the stone. When, however, it exists in the form of clay, as is sometimes the case (and probably clay exists to a small extent in all sandstones), it is adverse to the durability of the stone.

The oxide of iron is interesting as forming the colouring matter of the red varieties of sandstone; but it exists in all to a greater or less extent. It appears somewhat anomalous, but it is the fact, that some of the whitest specimens contain more oxide of iron than those of a bright red colour. Thus the Kenmure and Overwood stones gave, on analysis, respectively, 2·62 and 2·5 per cent. of oxide of iron; while the Bothwell Park and Wemyss Bay samples gave only 0·98 and 1·05 per cent., or less than half the quantity. The colour of a stone, therefore, does not give the slightest clue to the amount of oxide of iron it contains. The smallest proportion in any of the specimens is in the Ravenscraig stone, which remains perfectly white when calcined, while all the rest become more or less coloured when ignited. My idea is that in the red stones, such as Corsehill and Wemyss Bay, the oxide of iron exists in the free or uncombined state—that is, mechanically mixed with the other constituents; while in the white varieties it is in combination, probably as a silicate of the protoxide. In yellow stone, such as the Polmaise, it probably exists in the free state, but in a hydrated condition, as these stones become bright red when subjected to a strong heat. It is well known to builders that some kinds of sandstones are liable to become disfigured with blotches, or spots of oxide of iron. This arises from patches, or nodules of pyrites, in the stones, which are readily altered by exposure to air and water, forming sulphate of iron, which gives yellow hydrated peroxide on coming to the surface; the sulphuric acid being taken up, wholly or in part, by the lime and magnesia present in the stone.

The remaining mineral constituents of sandstones—phosphate and sulphate of lime—exist in quantities too minute to exercise an appreciable influence in their hardness, strength, or durability. They are interesting rather from a scientific than a practical point of view.

The quantity of water retained after long exposure to the air in a moderately dry atmosphere is very small, and varies from a mere trace up to about 2 per cent. There is no reason to doubt that it is influenced by the temperature and degree of humidity of the air.

We have now two physical properties of sandstones to consider; their weight or specific gravity, and their porosity, as indicated by the quantity of water they absorb when immersed in that liquid.

The table shows the specific gravity, and, calculated from that the weight of a cubic foot in pounds, and the number of cubit feet in a ton. In all cases the stone was air-dried. The lightest stones were the Ravenscraig, Bothwell Park, Corsehill, and Wemyss Bay, and the heaviest were the Kenmure, Overwood, Craigleith, and Polmaise—the heaviest of all being the Kenmure, with its 9 per cent. of carbonates of lime and magnesia. The latter weighs 144 lbs. per cubic foot, while the Bothwell

Park weighs only 127½ lbs., a difference which is very striking.

The quantity of water the stones are capable of absorbing appears to be closely connected with the specific gravity, The best stone in this respect is the Craigleith, which takes up only 3·4 per cent; the Kenmure comes next, with 3·9 per cent; the Polmaise faintly pink or white stone, which is very high in lime and magnesian carbonates, is nearly as good, with 4·4 per cent. The Overwood and Dunmore stones take 5 and 5·1 per cent, and the Giffnock and Ravenscraig 5·9 and 6·1 per cent respectively. The Polmaise yellow stone takes 5, and the Inverkip slightly pink stone 5·5 per cent. The greatest quantity is absorbed by the red stones, which take up respectively 6·1, 6·4, and 7·2 per cent—the last proportion being that taken by the Wemyss Bay stone.

I am not inclined to dogmatise in the matter of the interpretation of these results, but I think you will have no difficulty in agreeing with me that, as a general rule, a sandstone is the better the heavier it is, the less water it absorbs, and the more its pores are filled up with cementing material, such as the carbonates of lime and magnesia. Taking all these considerations together, I would prefer for building purposes, of the twelve stones contained in the table, the Polmaise light-coloured stone and that from Kenmure, both of which I would regard as of first-class quality. Again, among the other white stones, I would not hesitate to prefer the Overwood and Dunmore stones to that from Ravenscraig. The three dark red stones I would consider inferior in quality for outside work, especially in the atmosphere of a city, which is something distinctly different from the air of the open country.

The usual form of decay of sandstones is simply the disintegration of the surface, the binding material being removed by climatic influences, and nothing left but the sand, which may be rubbed off freely with the hand. There is, however, another form of disintegration which I had a few years ago occasion to investigate—that in which the surface comes away in distinct scales. The building was a ducal mansion of large dimensions, and a sandstone was used which contained an unusually large proportion of alumina, with a very fair quantity of carbonate of lime. After a year or two the surface began to scale off, particularly at angles, curves, and other exposed parts, especially close to the ground; and the scales were about one-eighth of an inch thick and very uniform. I found that the original stone contained 5·2 per cent of carbonate of lime, while in the scales it was reduced to 2·04 per cent. I had no doubt at the time, nor have I any doubt now, that the reduction of this ingredient was closely connected with the disintegration, if not its actual cause.

Sandstone is very porous, and absorbs water with avidity. A moderate shower of rain falling on the surface of a building constructed of freestone is entirely absorbed, at least at first, until the surface becomes saturated with water. The carbonates of lime and magnesia are only very slightly soluble in pure water, but much more so in water containing carbonic acid, as all waters do to a greater or less extent, although the proportion in rain-water is very small. Every shower that falls, therefore, removes a certain very minute quantity of these binding materials, and in a correspondingly minute degree weakens the stone. But this same operation, constantly repeated year after year, begins by-and-bye to tell upon the stability of the surface, and particularly if the stone have only a minute quantity of the earthy carbonates to start with. In towns we have also sulphuric acid in the air in appreciable quantity, and the rain that falls first is generally acid to litmus paper. This is derived from the sulphur in coal, and from various manufacturing operations, and, of course, is more abundant in large and closely-built towns than in those which are small and widely spread out. It follows that a stone which stands well enough in the country, or in a small town or village, may be very unsuitable for a large city; and the same thing applies to roofing slates, some of which are much more affected by acids than others.

If the walls of houses were entirely vertical, without any horizontal surface to catch the rain, the deterioration of stone would go on with extreme tardiness; but, as a matter of fact, there is a great deal of horizontal work about our houses and other buildings, consisting of window sills and lintels, porches, capitals, string courses, plinths, and so on—all these forming receptacles for catching the rain, a large proportion of which percolates through the stone and appears at a lower level. If you examine a few of the more recently erected buildings in Glasgow, where disintegration of the stone has set in, you will find that the process always shows itself first immediately below a flat projecting surface, and frequently there is no apparent injury to the stone elsewhere. The flow of rain-water over the surface of stone injures it only very slowly; the greater part of the damage is done by water passing through the stone, entering on a flat, or nearly flat, surface, and passing out at a lower level. In this way the stone in ordinary weather, alternately fair and rainy, never gets time to dry, but is always more or less damp.

The form of architecture adopted by the Greeks, and which in its pure or modified form is much used in city architecture, is well suited for a dry and warm climate, but much less so for a humid condition of atmosphere, such as that which obtains in this country. The Gothic style of architecture, whether accidentally or intentionally I cannot say, is better adapted to our climate, since the projecting courses of masonry are for the most part in the form of pointed arches, which permit the water to run rapidly off. Not that I would for one moment suggest that we should discard the Greek and Italian styles and adopt the Gothic; but I think something might be done to render these styles compatible with the exigencies of our over-humid climate. This brings me to what is, perhaps, the most important part of my communication—*i.e.*, the suggestion of means by which the decay of sandstone may be prevented or retarded.

Of course, the first consideration is to select for a building—and especially if it be one of a public and important character—a stone of the first quality. Next in order of importance is the covering of all flat, or nearly flat, surfaces with something that will prevent the rain which falls from passing through the stone. But I would advise architects, as far as possible, to avoid flat surfaces, and to give to window-sills and all projections as steep a slope as is consistent with the character of the building. A plan which I have advocated, and which is particularly adapted to projecting work at a considerable elevation, is to fill in the angle with Portland cement, so as to make a rather steep slope, which will completely prevent water from lodging or passing through the porous stone. This has also the merit of securely covering the joint between the projecting course of masonry and the flat stone immediately above it. When the use of cement is objectionable the slightly-sloped surface should be coated twice or three times with a tolerably strong solution of water-glass or silicate of soda, which will effectually fill up the pores and prevent water from passing through the stone. White-lead paint mixed with boiled oil may also be used, but it must not be applied to the stone until it is perfectly dry, and three or four coats are required. If all the projecting surfaces are thoroughly protected in any of these ways, the covering of the perpendicular surfaces is of comparatively little consequence, and will not be required unless the stone is of very bad quality. In extreme cases it is necessary to coat the whole surface with oil paint or silicate of soda,—both of which, however, are inapplicable to a grand public building, the painting of which would be justly considered as an act of Vandalism as great as the plastering up of the grand old Gothic columns in some of the English cathedrals, which was practised in an age more remarkable for sturdy piety than for cultivated taste and artistic skill. There is a material, however, which I may mention to you, which gives a complete and imper-

vious coating to polished ashlar without materially changing its colour or general appearance. It is prepared by the Broxburn Oil Company, and is called "Alexinoton, or Damp Repeller," I am not at liberty to state the composition of the liquid, but may merely say that it is a solution of a solid body in a highly volatile liquid. When applied to a wall the volatile solvent speedily evaporates, and the deposited solid completely fills up the pores on the surface, and renders the stone impermeable by water. This liquid may be applied not only to flat, or nearly flat, surfaces, but to an entire building, and I consider it particularly valuable for coating elaborate work, such as the capitals of pillars.

Where an entire building is coated with an impervious substance—which, in the case of ashlar, may be any of the liquid applications I have mentioned, and in rubble-work or brick may be Portland cement or mastic—it is of the utmost importance that the walls should be allowed to dry first. A two-foot wall will take, at the very least, two years to dry, and the quantity of water that passes away from it is larger than might be supposed. A fair-sized country villa, say 50 feet square and 30 feet high, will contain about 8000 cubic feet of solid masonry, weighing about 500 tons, which will contain, as originally built, about 25 tons of water, or 5600 gallons,—and all this has to be evaporated before the house is comfortable or safe to live in. Probably it makes its escape about equally from the outside and the interior; but, at all events, the process is a slow one, and in the case of buildings not protected by a damp course from water sucked up by the porous stone from the foundations, it is never complete. It is, therefore, unwise to coat the walls of a house with an impervious coating until towards the close of the second summer after the completion of the house. This rule does not apply, however, to coating the flat and other projecting surfaces, which may be carried out at any time during dry weather.

A NEW METHOD FOR THE VOLUMETRIC DETERMINATION OF PHOSPHORIC ACID IN THE SUPERPHOSPHATES.

By A. MOLLENDA.

AFTER a general description of the superphostates, the author proceeds to say that, confining his attention to such superphosphates as contain no free acid, he has considered the possibility of determining the percentage of phosphoric acid of the acid calcium phosphate by titration with normal soda or sodium carbonate. It is known that 1 mol. of calcium phosphate requires 2 mols. sulphuric acid to form 1 mol. acid calcium phosphate. The titration of a solution of superphosphate with normal soda requires that the acid calcium phosphate should be so far neutralised with alkali as to form merely the ordinary sodium phosphate. As in a solution of superphosphate, calcium sulphate is present along with acid calcium phosphate; and as the former is readily decomposed during titration with sodium carbonate, which would be inconvenient for the determination of the soluble phosphoric acid, the lime must be removed from the solution of superphosphate before titration. This is best effected by means of sodium oxalate, for ammonium oxalate is readily decomposed on heating with sodium carbonate, giving off free ammonia, and rendering accurate titration impossible. Sodium oxalate converts acid calcium phosphate into acid sodium phosphate. The sodium oxalate may be added in excess. The sodium sulphate formed, being a neutral salt, does not act upon litmus, and is therefore not injurious in titration.

The determination of the phosphoric acid in a superphosphate by titration with normal sodium carbonate is thus conducted:—Ten grammes of the powdered and sifted sample are dissolved in water, made up to 500 c.c., let stand for four hours, shaking frequently, filtered, and portions—each of 100 c.c.—are measured off for titration. Of this solution 100 c.c. represent exactly 2 grms. superphosphate. These 100 c.c. are heated to boiling in a beaker supersaturated whilst boiling with sodium oxalate, filtered after the precipitate of calcium oxalate has subsided, well washed, and the filtrate and washings are titrated after adding a few drops of pure neutral tincture of litmus. (As indicator azolitmine is recommended, a blue colouring matter extracted by Stolba's process from the ordinary tincture of litmus.) The liquid to be titrated is raised to a boil, and normal sodium carbonate is added from a burette until the liquid is distinctly blue. It is then still boiled for a few minutes, and let cool. If when cold the solution takes a reddish violet colour the titration is not complete. It is therefore heated again, and from 0·1 to 0·2 c.c. of the normal sodium carbonate is cautiously added, repeating this operation till the liquid remains blue when cold. The c.c. of normal sodium carbonate consumed are read off and noted.

If dissolved bones are titrated the beaker containing the solution must be set upon white paper, as the liquid itself is yellow, and with tincture of litmus appears reddish yellow. When the titration is complete it takes a greenish grey colour. With the ammoniacal superphosphates good results are not obtained, as ammonium sulphate is decomposed in heat by sodium carbonate. It is therefore preferable to titrate ammoniacal superphosphates in the cold with normal caustic alkali.

The author has also tried the titration of the soluble phosphoric acid with semi-normal soda. The lime was first removed from the solution with sodium oxalate, and the filtrate titrated. The process is trustworthy, and is simpler than that with sodium carbonate, as it is performed in the cold. On this account ammonium oxalate can be used instead of sodium oxalate for the removal of the lime, as there is no fear of its being decomposed by the alkali. From the same reason ammoniacal superphosphates may be titrated with caustic soda.

If a superphosphate contains free acid (sulphuric or phosphoric) the difficulty may be overcome by adding to the solution, drop by drop, lime-water or sodium carbonate until a faint turbidity appears, which does not disappear on stirring. This partial neutralisation is effected before the removal of the lime with ammonium or calcium oxalate. As a precipitate formed may contain phosphoric acid combined with iron or lime, the quantity of sodium carbonate solution required for neutralisation is best ascertained by a separate experiment. So much is then added to the liquid to be titrated that it just remains clear, and the lime is then removed at a boil with sodium oxalate.

When titrating in the cold with normal soda, phenol-phthaleine or phenacetoline may be advantageously used as indicator. The process may be still further abridged by not filtering off the precipitate of calcium oxalate, but adding at once to the milky liquid when cold a few drops of phenol-phthaleine, and titrating at once. The first drop of soda in excess gives a red colour.—*Zeitschrift für Analytische Chemie.*

The Petroliferous Beds of Central Europe.—L. Piedbœuf.—A very full account of the petroleum beds of North Germany, and of the attempts at their utilisation. The author states that a well opened last June, at Oelheim, in the Hanoverian district, has since then yielded regularly 35 barrels daily. A well at Sloboda Rungurska, in Gallicia, yields daily 45,000 kilos. of petroleum, or more than 275 barrels. It is said that, as regards price and quality, the German and the American petroleum meet on an equal footing in the market at Bremen. The German petroleum yields especially certain heavy oils, which for lubricating purposes seem superior to similar products from America.—*Revue Univ. des Mines, &c.*, No. 1, 1883.

DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

Second Paper.

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Concluded from p. 220).

Albumenoid-Ammonia Process.

The examination of modified forms of this process was undertaken by Dr. Charles Smart, U.S.A., who has furnished the following statement of results obtained. The appointment of Dr. Smart to the office of Secretary to the National Board of Health, and the pressure of duties thus entailed upon him, have prevented the whole plan of experiments intended being carried out, but the main points on which information was sought have been covered.

"The experiments detailed below were intended to determine the conditions under which ammonia in small quantities is evolved from its containing liquid, and those under which perfect condensation or absorption may be subsequently obtained.

Series of Experiments on the Liberation and Condensation of minute quantities of NH_3.

The charge for distillation consisted of so many c.c. standard NH_3 solution (1 c.c. = 0·01 m.grm. NH_3) + so many of ammonia free water, making a total of 500 c.c.

A. 1 m.grm. NH_3, ordinary distillation. Temperature of distillate 27° C.

0·50 0·21 0·055 0·01 = 0·855 = 14·5 per cent loss.

Compare with H and I.

B_1. 0·5 m.grm. NH_3, ordinary distillation. Temperature of distillation 28° C. Temperature in retort 101° C.

0·40 0·06 0·005 = 0·465 = 7 per cent loss.

B_2. 1 m.grm. NH_3. Conditions as in B_1.

0·76 0·10 0·01 0·00 = 0·87 = 13 per cent loss.

Compare with A in which gas-jet was smaller and time of distillation longer.

B_3. 2 m.grms. NH_3.

1·34 0·32 0·05 0·01 50·00 = 1·725 = 13·75 per cent loss.

C_1. 1 m.grm. NH_3, receiver closed by sulphuric acid bulbs, connected with water-jet, tension reduced 6 inches; retort heated in vessel of boiling water. Temperature in retort 95° C., of distillate 28° C. Distillation slow (90 minutes for 50 c.c.)

0·46 0·28 0·14 0·035 0·015 with 0 01 in acid = 0·94 = a loss of 6 per cent.

C_2. 2 m.grms. NH_3. Temperature in retort 96° C.; other conditions as in C_1.

0·77 0·56 0·27 0·12 0·06 0·025 with 0·035 in acid = 1·84 = a loss of 8 per cent.

D_1. 0·5 m.grm. NH_3. Conditions as in C, but flame applied to retort. Temperature in retort 97 to 97·5° C., of distillate 28° C. Distillation rapid (12 minutes for 50 c.c.)

0·36 0·075 0·01 with 0·02 in acid = 0·465 = a loss of 7 per cent.

D_2. 1 m.grm. NH_3.

0·72 0·20 0·035 0·015 with trace in acid = 0·97 = a loss of 3 per cent.

D_3. 2 m.grms. NH_3.

1·41 0·36 0·05 0·01 and trace only in acid = 1·83 = a loss of 8·5 per cent.

E_1. 0·5 m.grm. NH_3, ordinary distillation, but receiver closed by sulphuric acid bulbs. Temperatures 101° and 28° C.

0·37 0·075 0·015 with 0·02 in acid = 0·48 = a loss of 4 p. ct.

E_2. 1 m.grm. NH_3.

0·72 0·19 0·035 0·005 with 0·02 in acid = 0·97 = a loss of 3 per cent.

E_3. 2 m.grms. NH_3.

1·39 0·34 0·07 0·01 with 0·03 in acid = 1·84 = a loss of 8 p.ct.

Compare E with B_1.

F_1. 1·5 m.grm. NH_3. Conditions as in E, but pure water in bulbs instead of sulphuric acid.

1·12 0·20 0·02 0·005 = 1·345 = 10·3 per cent loss.

G_1. 0·5 m.grm. NH_3. Conditions as in F, but with water-flask as guard beyond the water-bulbs.

0·37 0·07 0·015 = 0·455 = a loss of 9 per cent.

G_2. 1 m.grm. NH_3.

0·72 0·18 0·03 0·0025 and trace in bulb = 0·9325 = 6·75 per cent of loss.

G_3. 2 m.grms. NH_3.

1·41 0·32 0·065 0·01 with trace in water = 1·805 = a loss of 9·75 per cent.

Compare G with E and B.

H_1. 0·5 m.grm., ordinary distillation. Temperature o distillate 6° C.

0·40 0·08 0·02 0·00 = 0·50.

H_2. 1 m.grm. as in last.

0·80 0·14 0·03 = 0·97 = loss of 3 per cent.

H_3. 1 m.grm. as in last.

0·80 0·15 0·03 = 0·98 = loss of 2 per cent.

I_1. 0·5 m.grm. condensed in coil 18 feet long. Temperature of distillate 6° C.

0·08 0·32 0·08 0·015 0·005 = 0·50

I_2. 1 m.grm. as last.

0·43 0·38 0·12 0·04 0·01 = 0·98 m grm. = loss of 2 per cent.

I_3. 1 m.grm. as last.

0·35 0·40 0·12 0·07 0·03 = 0·97 m.grm. NH_3 = loss of 3 p. ct.

Second Series of Experiments on the Liberation and Condensation of minute quantities of NH_3 *from Water.*

I. 0·5 m.grm. NH_3, in a retort connected with a water-jet pump, no condenser, but sulphuric acid bulbs between retort and pump, 6¾ inches pressure removed; stream of air passing through apparatus entering by means of a glass wool filter moistened with sulphuric acid. Temperature 28° C. After twenty-four hours 0·11 m.grm. NH_3 was found to have left the retort for the acid bulbs.

II. 0·5 m.grm. NH_3, apparatus as in I, but temperature in retort kept at 63° C. At the end of twenty-one hours, 190 c.c. of the water were found to have passed into the acid bulbs and flasks, carrying with them all of the NH_3.

III. 0·5 m.grm. NH_3, apparatus as last. Temperature in retort 55° C. At end of eighteen hours, 85 c.c. were found to have passed over, carrying with them 0·488 m.grm. NH_3.

IV. As last. At end of six hours, 31 c.c. had passed over with 0·29 m.grm. NH_3.

V. As last, but with the air drawn *through* the liquid to cause an artificial ebullition. At the end of five hours, 0·27 m grm. was found in the acid.

VI. As last, but with 9 inches pressure removed. Temperature 50° C. At the end of sixteen hours, 60 c.c. had come over, bringing all the NH_3.

VII. As last. At end of four hours the 10 c.c. which had come over contained only 0·25 m.grm. NH_3.

VIII. As last, but with 10½ inches pressure removed. Temperature 49° C., and 6¼ hours of exposure, 13 c.c. passed over containing 0·27 m.grm. NH_3.

Experiments on the Decomposition of Urea during Distillation of the Water holding it in Solution.

The urea used in these experiments contained 0·45 per cent of free NH_3. This amount must be deducted from the first recorded results of every experiment.

1st. 10 m.grms. urea (containing 0·045 m.grm. NH_3) in 500 c.c. water distilled from water-bath, and with 6½ ins.

* Report on the results of a supplementary investigation, made by the direction of the National Board of Health. From *American Chemical Journal*, vol. iv., No. 6.

pressure removed from interior of apparatus. Temperature in retort 96° C. Two hours required for the distillation of each measure of 50 c.c.

Result 1st measure 0·19 m.grm.
2nd „ 0·37 „

2nd. 10 m.grms. urea, but without the water-bath and jet-pump. Distillation rapid: twelve minutes for 50 c.c.

1st measure 0·12 m.grm.
2nd „ 0·10 „

3rd. 20 m.grms. (containing 0·09 m.grm. NH_3) operated on as in experiments I., II., III., &c. At the end of five hours 40 c.c. had passed over, carrying with them 0·19 m.grm. NH_3 into the acid.

4th. 20 m.grms. urea were permitted to remain under the influence of the jet-pump and passing air current as in I. for forty hours: 0·14 m.grm. was found in the acid.

5th. 20 m.grms. were exposed in solution to the air for forty hours, and at the end of that time showed the presence of 0·09 m.grm. NH_3 as when freshly dissolved.

6th. 20 m.grms. at 60° C. and 6½ inches for seven hours gave 0·20 m.grm. NH_3 in 40 c.c. which passed over into the acid bulbs.

7th. 20 m.grms. at 60° C. and 6½ inches for sixteen hours gave in 65 c.c. distilled 0·25 m.grm. = 0·16 m.grm. when the 0·09 free NH_3 is deducted.

8th. 35 m.grms. urea (containing 0·16 m.grm. NH_3) at 55° C. and pressure as in last gave after sixteen hours 67 c.c. containing 0·29 m.grm. NH_3.

9th. 35 m.grms. urea as in last, but with only six hours exposure, gave 0·035 in 26 c.c. distilled. This 0·035 represents the decomposition effected during the time, as the residue from 8 was used, and it was free from the original ammonia taint of the urea.

10th. The residue from 9, treated as before for sixteen hours, gave 0·09 in the 70 c.c. which passed over.

A comparison of C and D shows that water containing a trace of ammonia may be heated within a degree or two of its boiling-point without any rapid evolution of the ammonia, but that as soon as the extra degree or two needful to cause ebullition has been added, the ammonia passes over rapidly with the watery vapour. Ninety minutes of a heat just below the boiling-point are required to accomplish what may be effected in twelve minutes if that point is attained. A reduction of pressure on the surface of the liquid promotes the evolution, by causing ebullition at a lower temperature; compare D with E. A diminished pressure no doubt acts at all temperatures in aiding the evolution; and a weak solution, as in I., may lose its ammonia at ordinary temperatures, but the length of time required to effect this renders the process valuelesss as a practical method. Nevertheless, by increasing the temperature under the lessened pressure, the time required may be so reduced as to give the process a value in practice.

As the rapidity of the evolution of the ammonia from the water containing it depends mainly on the presence of heat sufficient to boil the water, so a perfect condensation, where heat has been applied to cause rapid evolution, can only be obtained by the needful reduction of temperature: compare the whole series A, B, and C with H and I. Where the condensing liquid runs freely from the tap through the condenser so as to give the distillate a temperature a few degrees above the freezing-point, the ordinary condenser is as efficient as one with a condensing tube many times longer: compare H and I.

But where the liberation of the ammonia is effected slowly under reduced pressure and at temperatures considerably below the boiling-point, the whole may be recovered by absoaption in acid without the aid of a condensing circulation. See experiments II., III., and VI.

As with the evolution of ammonia so with the decomposition of urea: it is effected slowly at temperatures below the boiling-point, but as soon as that point is reached the ammonia from its dissolution is given up rapidly. Compare experiment 2 with the others of that series.

Practically it may be said that where we are dealing with free ammonia and non-volatile and stable organic matter in a water, the ordinary process with a condensing medium which gives a proper temperature to the distillate may be considered satisfactory.

But where we have to discriminate between free ammonia and urea, the slower method by absorption in acid under reduced pressure may be of value. The experiments 3 to 8 show that if the operation is commenced in the afternoon and permitted to continue until next morning, the whole of the ammonia may be expected in the acid bulbs, and this may be assumed with greater certainty if more than one-tenth of the liquid has distilled in the meantime; but if the operation is commenced in the morning or forenoon, it is doubtful if it can be completed in the ordinary working hours of the laboratory. Experiments 7 to 10 indicate that during this liberation of the free ammonia present, the urea which may accompany it will only suffer decomposition to the extent of from three- to eight-tenths of one per cent.

CH. SMART, U.S. Army."

PERMANGANATE PROCESS.

Maintenance of an approximately constant excess of Permanganate during the progress of action on the Organic Matter in a sample of Water.

The effect of thus modifying the permanganate process as described and used by Tidy was tested as follows:—The process was first applied in its usual form to water artificially polluted with organic matter,* extending, however, the time of action to twenty-four hours, and making determinations in separate flasks of the oxygen consumed at the end of one, three, six, nine, twelve, and twenty-four hours respectively. Enough of the organic matter was used to consume altogether a large proportion of the oxygen of the charge of permanganate. Having plotted off a curve on paper representing the rate of consumption of the oxygen as thus found, it was determined how much additional permanganate should be added at the end of each half-hour for the first three hours, at the end of each hour for the succeeding nine hours, and at the end of each six hours for the remaining twelve hours, in order to maintain, as nearly as these intervals would permit, a constant excess throughout the whole period. These additions were made at the proper times to a new lot of the polluted water altered only by keeping for one day, and determinations were made as before of the oxygen consumed at the end of one, three, six, nine, twelve, and twenty-four hours.

Results a little higher were obtained by this modified process as compared with those given by the former method. The difference, however, was not very great. The chief evidence of greater regularity of action was furnished by experiments, made simultaneously, on two different dilutions of the same solution of organic matter.

These gave results as to oxygen consumed which were almost exactly in proportion to the difference of strength when the modified process was used, whereas the stronger solutions gave somewhat lower results than would have been calculated from those for the weaker dilutions when the original form of the process was applied. These comparative experiments were too few in number to generalise from with much positiveness, but they may fairly be taken, as far as they have gone, in confirmation of the soundness of the principle on which the suggested improvement is based.

Specific Heats of Certain Gases at High Temperatures.—M. Vieille.—The author has verified the identity of the specific heats of hydrogen, nitrogen, oxygen, and carbon monoxide gases at temperatures up to 2700°.—*Comptes Rendus.*

* An infusion of dead forest leaves and the drainings from a pile of animal manure were the polluting materials used.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, May 12th, 1883.

Prof. Clifton, President, in the Chair.

New Member, Mr. A. W. Soward.

Mr. Woodward described "*An Experiment Illustrating Motion produced by Diffusion.*" A porous reservoir of clay containing air was suspended from one end of a weighted balance beam. A glass tube projected from it below and dipped into a vessel of water. A jet of hydrogen gas was allowed to play on the outside of the reservoir, and the balance beam began to oscillate. This is an adaptation of Graham's well-known experiment, and is, in fact, a diffusion engine.

Prof. Adams explained the action by the variations of pressure in the reservoir set up by diffusion.

Mr. W. Lant Carpenter read a paper on "*Some Uses of a New Projection Lantern.*" This lantern, of German make, is supplied by Mr. Paterson, and is simple in construction, cheap, and gives a good image visible to a large audience. It can be used with a three-wick oil lamp or the lime-light. Mr. Carpenter showed a number of objects on the screen.

Mr. Lecky and Mr. Woodward offered some remarks, the latter deprecating a too frequent use of projection with students.

Dr. C. R. Alder Wright read a paper on the "*Electromotive Force of Clark's Mercurous Sulphate Cell, and the Work Done during Electrolysis.*" He described the best mode of constructing Clark's standard cell. According to numerous tests these cells vary in E.M.F. about 0·2 per cent + or − among themselves. A cell properly made will keep its value for about two years. It is of great importance that the cell should not be worked or the current reversed through it, otherwise it may permanently deteriorate. The extraction of air from the paste is not very essential, and boiling it is unnecessary. It is more important that the solution of zinc sulphate should be saturated. Dr. Wright described a cell in vacuum, which is a good standard. He found the E.M.F. to vary 0·4 between 0° and 100° C. With regard to the work done in a cell, among other interesting deductions he found that in a secondary battery the larger the plates the greater the economy. In the electrolysis of water, the greater the surface-condensing power of the electrodes for gas the less difference of potential is required to decompose the water. Thus with platinum electrodes a lower E.M.F. serves for the electrolysis than with gold electrodes.

Prof. Foster then took the chair, and

Prof. Clifton read a paper on a "*Complete Determination of a Double Convex Lens by Lineal Measurements on the Optical Bench.*" This was a method (somewhat similar to that of Mr. Boys previously described to the Society) for determining the four quantities of a lens on the bench by lineal measures, and without the use of the spherometer and prism. Experiment showed that it was as about as accurate as the spherometer method.

NOTICES OF BOOKS.

A Manual of Photographic Chemistry, Theoretical and Practical. By Rev. T. F. Hardwich, M.A. Ninth Edition. Edited by J. Traill Taylor. London: J. and A. Churchill.

The title of this work does by no means fully and adequately indicate its contents. In addition to photographic chemistry it contains two chapters treating on the optics of the art, and no inconsiderable amount of matter which comes under the head of practical instruction rather than under that of chemical principles. These portions of course must add to rather than detract from the value of the book as a photographer's manual, but they are not indicated in the title.

Among the changes introduced in the present edition is the introduction of the modern atomic weights of the simple bodies, and the nomenclature of their compounds. The editor remarks with much reason that he did not consider it judicious entirely to discard the old nomenclature in favour of the new. The old system is in fact still largely in use not merely among photographers, but among well-nigh all classes of persons practically engaged in the chemical arts. But we should suggest that the best way of introducing the new names would be to place them in parentheses after their older synonyms, or else to invert this arrangement.

In the table of elementary bodies we find the more than questionable Davyum, whilst scandium, ytterbium, terbium, and thulium do not appear. In the table of symbols and molecular weights of the principal compounds used in photographic practice, we find a few irregularities. Thus the author speaks of potassium nitrate, sodium nitrate, but instead of "barium nitrate," he retains "baryta, nitrate of." He writes, conformably with modern usage, "ammonium bromide, chloride, iodide," &c., but, suddenly returning to the old nomenclature, he puts "ammonium, sulphocyanide of." This irregularity, we fear, will prove somewhat confusing.

In the section on the chemistry of organic compounds we find the doctrine of dualism still asserted. It is written: "Inorganic bodies, as already shown, unite in pairs—two elements join to form a binary compound; two binary compounds produce a salt; two salts associated together form a double salt." This view is not now accepted as orthodox. Speaking of organic compounds, the author says: "The bases are also a large class. Morphia, obtained from opium; quinia, from quinine; nicotine, from tobacco, are illustrations." This passage conveys the impression that quinine, instead of being a synonym for quinia, is a raw material, like opium and tobacco.

There is here also some repetition which might be avoided. In Chapter II. we have a "Vocabulary of Photographic Chemicals" with an account of the silver bromide, iodide, chloride, nitrate, &c. But the next chapter is devoted to "The Salts of Silver employed in Photography," and contains to some extent the same matter which occurs in the foregoing chapter.

Chapter IV. gives an account of the various substances used as reducing agents, and here again we find information which has already figured in Chapter II. Under "Fixing Agents," in Chapter V., we also notice some repetitions. In short, we must take the liberty of saying that the earlier chapters of the work stand in need of a thorough revision.

In the succeeding chapters, which deal more with the practical part of the subject, the author and editor have felt more at home. The description of the gelatine emulsion process is here a very important addition. But, as the editor expressly mentions, it would be a great mistake to consider the collodion process as superseded. On the contrary, the demand for collodion, according to the testimony of one of the largest makers, is more extensive than ever. The chapter on the optics of photography is highly satisfactory. In short, there is needed merely a revision of the earlier chapters to render the work practically unexceptionable.

The Geological Record for 1878. An account of Works on Geology, Mineralogy, and Palæontology Published during the Year, with Supplements for 1874—1877. Edited by W. Whittaker, B.A., F.G.S. London: Taylor and Francis.

The appearance of this volume has been delayed in part by the great increase in the quantity of geological work

to be summarised, but still more to the non-arrival of the MS. for the sections America and Arctic Regions. The present volume, as before, is divided into sections dealing respectively with stratigraphical and descriptive geology, physical geology, applied and economic geology, petrology (including meteorites), mineralogy, with mineral waters, palæontology, maps and sections, and miscellaneous matter. There are also important supplements, addenda, and indices.

In the stratigraphical and descriptive portion we still notice the paucity of work in Asia, Australia, and still more in Africa and Oceania. This deficiency is of course not the fault of the zealous editor and his coadjutors.

Under the head Physical Geology we find notice of a memoir by Sir G. Airy on the probable condition of the earth's interior, in which he suggests that portions of the entire mass of the planet differ respectively very much in density. There is also an abstract of Dr. Croll's theory of the origin of nebulæ and the cause of solar heat, which he ascribes to the collision of two bodies moving in space with great velocity. Mr. G. H. Darwin thinks that Europe and Asia might have been elevated in less than 20,000 years and yet leave no record in the present motion of the earth, and that Haughton's method fails to give a clue to the question of geological time. Prof. J. A. Church finds that the well-known excessive heat of the Comstock Mine has no relation to fixed levels, but is due to chemical action going on in the rocks. Mr. H. Hennessy shows that the reasonings of Sir W. Thomson and Mr. G. H. Darwin on the tidal action of an internal fluid on its shell are vitiated by the assumption of an incompressible fluid and an elastic, and therefore compressible, solid. A highly compressible liquid contained in a much less compressible shell would be a hypothesis more in harmony with observation. Hence the objections raised to the idea of an internal incandescent fluid do not hold good. Dr. A. Streng maintains that the interior of the earth may consist of a solid nucleus with a succession of alternate liquid and solia shells between this nucleus and the outer crust. Prof. J. Young asks how it is possible that 100 feet of till could accumulate under an ice-sheet some 2000 feet thick? C. Ochsenius discusses the origin of gypsum as a common associate of rock-salt. A gulf cut off from the open sea by a bar favours deposition of salt free from gypsum. Small proportions of sulphate of lime in salt deposits may be due to the high temperature of the water. Mud falls rapidly from warm concentrated saline solutions.

Prof. A. Cossa describes a potash-alum from the Isle of Volcano containing thallium, rubidium, and cæsium.

H. Hauenschild gives details as to an exact experimental reproduction of the characteristic surface-hollows of meteorites by means of streams of air directed at a great velocity upon red-hot matter.

A relatively considerable space is devoted to mineral waters. The rehabilitation of these liquids in England—not merely as medicines, but as ordinary beverages—is a striking instance of what may be effected by persistent advertising.

Not alone geologists, in the strict sense of the word, but many persons devoted to other sciences or to industrial arts will find the Geological Record a most useful work of reference.

A Manual of Chemical Analysis, as applied to the Examination of Medicinal Chemicals. A Guide for the Determination of their Identity and Quality, and for the Detection of Impurities and Adulterations. Third Edition, thoroughly revised and greatly enlarged. By F. Hoffmann, Ph.D., Public Analyst to the State of New York, and F. B. Power, Ph.D., Professor of Analytical Chemistry in the Philadelphia College of Pharmacy. Philadelphia: H. C. Lea's, Son, and Co.

Among the special branches of chemical analysis none is more important than that which relates to pharmaceutical preparations. Their great and increasing number, the frequent adulterations, or at least impurities, to which they are liable, and the importance which attaches to their purity, all render the work before us valuable and necessary. It must be borne in mind that the authors in this treatise take into consideration definite chemical compounds only. The crude natural products used in medicine, gums, resins, fatty oils, roots, &c., and their solutions or extracts are left unnoticed.

The work opens with an abridged treatise on qualitative analysis. The authors treat in succession of operations and apparatus, of reagents and test solutions; of the preliminary examination of an unknown substance, the systematic search for bases and acids; of volumetric analysis; of the general characters of the alkaloids, with a scheme for their systematic separation and detection. The principal properties of the ptomaines are stated, but their distinction from the vegetable bases is regarded as a yet unsolved problem.

The second and main portion of the book treats of the medicinal chemical compounds in alphabetical order. Under each we find its Latin name as used by English and American pharmacists, its German-Latin pharmaceutical name, often perplexingly unlike the former, and its pure chemical name in English, German, French, and Spanish. The most objectionable feature of the Latin nomenclature of the *Pharmacopœia Germanica* is that it gives to the bromides, iodides, chlorides, &c., names which seem to belong to the bromates, iodates, and chlorates. Thus the substance known as ammonium bromide, becomes, in the language of German pharmacy, "ammonium bromatum."

Beneath the names of each compound follows its formula, experimental and theoretical, and its molecular weight. Then follow its principal properties, its reactions, solubilities, the impurities most apt to be present, indications for their detection, and, whenever requisite, the quantitative valuation of the sample. It need scarcely be said that the instructions given, though primarily intended for pharmaceutists, are in numbers of cases no less valuable to the scientific and to the industrial chemist. In almost all cases we are happy to recognise here a most gratifying degree of thoroughness. Among the few omissions which we perceive is the possible occurrence of selenium in sulphuric acid.

As an appendix follows a series of tables. That of the atomic weights of the elementary bodies gives the most recent determinations, *e.g.*, the corrected weight of platinum. There are also tables showing the equivalence of the Centigrade and Fahrenheit thermometric scales, from $-40°$ to $+430°$ of the former, for converting metric measures of capacity into United States fluid measures, among which latter the grain measure does not seem to be included, and for converting metric weights into troy weight.

The work is throughout usefully illustrated, not merely with drawings of apparatus, but also with diagrams of the forms of crystals when calculated to aid in the recognition of compounds.

Death of Dr. James Young.—We greatly regret to learn the death of Dr. James Young, of Kelly, the founder of the paraffin manufacture, and one of our most eminent and successful industrial chemists. He died on the night of Sunday, the 13th inst., aged seventy-one. We shall give next week a sketch of the life of our deceased friend.

Prevention of Fires.—A public meeting will be held at the Society of Arts on the subject of the prevention of fires in theatres. The report of a committee of the Society, which has for some time been investigating the question, will be brought before this meeting for its consideration. The precise date has not yet been decided, but it will be held the end of the present month. Further particulars will appear in future numbers of the Society of Arts' *Journal*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 17, April 23, 1883.

Certain Relations between the Temperatures of Combustion, Specific Heats, Dissociation, and the Pressure of Explosive Mixtures.—M. Berthelot.—A thermo-chemical paper, not capable of useful abridgment.

Study of the Ultra-Red Radiations by Means of the Phenomena of Phosphorescence.—H. Becquerel.—(See p. 225).

Variation of the Refraction Indices of Water and of Quartz under the Influence of Temperature.—H. Dufet.—The author expresses his results in the form of tables.

Liquefaction of Nitrogen.—S. Wroblewski and K. Olszewski.—Having liquefied oxygen in a complete manner we proceeded to nitrogen. This gas, cooled in a glass tube down to −136° and submitted to a pressure of 150 atmospheres, still remained gaseous, and nothing could be seen in the tube. If suddenly released there is in the whole tube a tumultuous ebullition, comparable only with the ebullition of liquefied carbonic acid in a Natterer's glass tube, when plunged into water at a temperature a little higher than the critical point of carbonic acid. But if the release is effected slowly, and if the pressure whilst being reduced is not allowed to go beyond 50 atmospheres, the nitrogen is completely liquefied, presenting a very distinct meniscus, and evaporating rapidly. Thus nitrogen only remains for a few seconds in the static condition of stable liquids. In order to keep it longer in this state a temperature would be required lower than the minimum hitherto produced. Such a temperature the authors are seeking to obtain. Liquid nitrogen is colourless and transparent, like oxygen and carbon dioxide. The authors add that they have since liquefied carbon monoxide in the same manner, obtaining a colourless liquid, which shows a distinct meniscus.

Iodised Apatites.—A. Ditte.—The author sums up his results to the effect that the apatites and wagnerites form well-defined groups of compounds, presenting the same composition and the same crystalline forms. These bodies may indifferently contain chlorine, bromine, iodine, fluorine; they take rise by the dry way under circumstances quite analogous, and their decomposition is subject to the same laws.

The Action of Water upon the Lime of Theil, and the Existence of a New Hydraulic Compound, Pozzo-Portland.—E. Landrin.—The new compound in question is formed when hydraulic silica absorbs lime. It tends towards a limit expressed by $3SiO_2,4CaO$.

Certain Phenolic Derivatives.—L. Henry.—The compounds in question are the oxide of mono-chloro-phenyl-ethyl, phenyl-ethyl-oxylic ethylene, mono-bromo-phenyl-allyl oxide, and propargylic phenol.

Moniteur Scientifique, Quesneville. April, 1883.

Present State of the Alkali Manufacture.—Walter Weldon.—From the *Journal of the Society of Chemical Industry*.

Patents concerning Artificial Colouring-Matters.—M. Gerber.—A series of specifications, chiefly of German origin.

Salicylic Medication in the Treatment of Typhoid Fever.—M. Vulpian.—A purely medical paper.

Present State of the Sulphur Trade in Italy.—M. Gerber.—An account of the geographical and geological distribution of sulphur deposits in Italy, its separation from the gangue, and its exportation.

Review of Foreign Chemical Researches.—G. de Becchi and H. Gall.—Extracts from the leading German chemical papers.

Industrial Society of Mulhouse.—Session of Feb. 14, 1883.—M. A. Scheurer presented, on behalf of M. A. Pabst, a memoir on the theory of the formation of compound ethers.

The Secretary announced that a memoir on the theory of Turkey-red dyeing had been received in candidature for prize No. 1 of the chemical arts.

M. H. Kœchlin read a memoir on the gallo-cyanines, already noticed.

M. Camille Kœchlin gave some interesting details concerning Turkey-red dyeing on the old system. The modification of the oil upon the fibre, from exposure on grass, takes place only under the influence of light. If a part of the cloth is covered, the oil on such part undergoes no change.

M. Saussure had observed that oil exposed to light may absorb 300 to 400 times its volume of oxygen. However little it may have been once rendered sensitive by the action of the sun, the absorption of oxygen with liberation of heat continues afterwards in the dark. In consequence of this phenomenon it is necessary to moisten or to air the cloth after the exposure on grass to prevent ignition. Linseed oil possesses this property in the highest degree. Oil which has been exposed to the sun or to a high temperature decomposes aluminous mordants, and the transformation which it has undergone may be measured by the quantity of mordant which it takes up. The absorption of oxygen, which demands precautions against spontaneous combustion, does not determine the condition of oiling. From a tinctorial point of view it remains a secondary reaction, for the red colour may be completed more rapidly than this process of absorption, or the latter may be continued to saturation without the shade manifesting any sensibility to what is going on. During insolation the glycerin is set free from the oil. To assist in this change oils are used in which a part of the oleic acid has been already set at liberty by fermentation. These oils, known as emulsive oils, form with the alkaline carbonates, emulsions, in which the oil does not rise up to the surface. The more these emulsions or white baths are alkaline the more readily they are acted on by light or heat, but the more the fatty compound retains its solubility. In practice the proportions are regulated by the weather and the arrangement of the stoves. The dyers were accustomed to add sheep's dung to the white baths, which, by its albuminous nature, strengthened the organic mordant. For the action of light may be substituted that of heat. The procedures based upon this substitution have the advantage of being independent of the weather, and of reducing the operations of applying the oil. These operations may consist of a single strong white bath or of a passage in pure hot oil. The cloth is then stoved at 80°, 100°, or 135° according to the duration of the process; 80° for stoving for several hours, or 135° for hot flues. Cloth steeped in pure oil takes a sulphur-yellow colour, followed by a darker and darker yellow, which passes into a brown, and finally into a black. The oil may be carbonised before the fibre. The action is best arrested at a nankin shade. This process is followed by some passages in alkaline water, drying between. The absorption of oxygen is more rapid and dangerous than after exposure to the sun; the cloth must be speedily spread out to prevent accidents. Pieces treated with linseed oil become carbonised if left rolled up or in heaps whilst moist. An oil which has been heated to 150°, 200°, 250°, 300°, and is then applied to cloth, absorbs oxygen immediately in its fine state of division. The absorption is the more energetic the more

strongly the oil has been heated. The final product is a solid resin. Charles Steiner, of Church, Lancashire, devised a process not requiring exposure on grass. This process, which introduced regularity into the numerous operations, as well as the red of MM. Braun and Cordier, was an intermediate step between the ancient process, and that with hydrated oleic acid, due to M. H. Kœchlin. In this process exposure to the sun or to heat is dispensed with, and accidents of spontaneous combustion or heating are not to be dreaded, the oxidation taking place slowly. It was formerly supposed that oiling animalised the fibres, and gave them transparency,—suppositions as contrary to chemical as to practical conditions. Though oiled tissues have the property of attracting the majority of soluble colouring-matters, like the salts of the oxides capable of acting as mordants, and of rendering colours more permanent, Turkey-red is, in fine, merely a madder-red, produced upon tissues in which oleic acid has been fixed.

M. Albert Scheurer stated that heating to 120° with hot water is sufficient to clear Turkey-reds which have been dyed in presence of a sulpholeate.

M. H. Kœchlin had observed that pieces cleared with 1-100th nitro-muriate of tin had spots of mould after the lapse of three or four months. Analogous accidents are still produced under other circumstances, and seem to occur generally when the pieces have been taken through an acid liquid before drying.

M. A. Scheurer is of opinion that clearing Turkey-reds consists in a dehydration of the alumina combined with a fatty body. M. Scheurer finds that the temperature at which water produces on a dyed swatch the highest degree of brightness (120° applied for two hours) is exactly that at which the mordant of another swatch prepared under the same conditions, but not dyed, is entirely dehydrated. The dehydrated mordants are with difficulty attacked by acids, and no longer possess the property of attracting colouring-matters. Clearing depends as much or perhaps more on the temperature to which the tissue is heated along with water as on the nature of the substances added.

M. Noelting, in his own name and in that of M. Wild, informed the Society that on causing ethyl-phenyl-nitrosamine to react upon aniline hydrochlorate in presence of an excess of aniline, ethyl-amido-azobenzol is formed, without secondary products.

MM. Noelting and Kohn, in order to complete their studies on the azo-derivatives of cresylol, have prepared the compounds of diazobenzol and of diazophenyl-sulphonic acid upon ortho- and meta-cresylol. The derivatives of ortho-cresylol yield, on reduction, a paramido-ortho-cresylol, transformable into toluquinone. The same amido-cresylol is also obtained by the reduction of nitroso-ortho-cresylol prepared by the action of nitrosyl sulphate upon ortho-cresylol. The reduction-products of the azo-derivatives of meta-cresylol are under examination.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 3.

Manurial Experiments on Sugar Beets on the Sierakowo Estate in 1882.—A. Tschuschke.—This paper does not admit of useful abstraction.

Changes in the Milk-Secretion under the Influence of certain Medicines.—Dr. Stumpf.—From experiments with goats it was found that small doses of potassium iodide produced an increase of fatty matter and of sugar, with little change in the albumenoids and saline matter. The reaction of the milk, which had been previously amphoteric, became alkaline, and remained so for seven days after the administration of iodine had ceased. Small doses of lead had no appreciable effect upon the quality and quantity of the milk. Morphine had no appreciable effect. Pure ethylic alcohol diluted with water produced no effect upon the quality of the milk; the solids increased, and the specific gravity decreased. The effects of beer were similar. A goat received daily 2 litres. The sugar and fatty matter in her milk were notably increased.

The Extirpation of Field-Mice.—Dr. Joseph and Dr. Crampe.—A fatal cutaneous disease is produced in rodents by the so-called "favus fungus" (*Achorion Schœnlinii*). The authors propose to apply this fungus to the skin of captured specimens, and then turn them loose to spread the infection.

Cosmos Les Mondes.
No. 15, April 14, 1883.

Preservation of Honey.—E. Mylius.—Crude honey is found to keep better than that which has been clarified. The author recommends the addition of 1 per cent of oxalic acid, which prevents fermentation without injuring the taste of the honey.

Combination-Heat of Glycolates.—Dr. D. Tommasi.—Already noticed.

No. 17, April 28, 1883.

Hydrogen and Antiseptic. The Egasse System.—The author proposes to dissolve zinc in hydrochloric acid, to sell the hydrogen gas for filling balloons, &c., and to utilise the zinc chloride as a disinfectant. (From the general tone of the article it would almost seem that the "inventor" considers this a novel application (!).

Archives Neerlandaises des Sciences Exactes et Naturelles, Tome xvii., Livraison 3me.

Osmosis of Salts considered in Relation with the Constitution of Solutions.—J. E. Enklaar.—The principal results laid down are that in a mixture of salts each preserves, in the common solution, its own osmotic speed; in other words they pass independently of each other from the common solution, through the membrane, into pure water. But when sodium chloride and hydrochloric acid pass from a common solution through a membrane into pure water, their osmotic velocities are lower than when separately submitted to osmosis. The influence exerted by hydrochloric acid upon the speed of the osmotic current of sodium chloride varies but little with the quantity of the acid. The author gives the caution that in series of osmotic experiments the bladders used should be obtained from animals of the same species and of the same age.

Tome xvii., Part 5.

Specific Rotatory Power of Apocinchonine and Hydrochlor-apocinchonine under the Influence of Acids.—A. C. Oudemans, Jr.—The author gives his results in tables not capable of abridgment.

MEETINGS FOR THE WEEK.

Tuesday, 22nd.—Institution of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
Wednesday, 23rd.—Society of Arts, 8.
—— Geological, 8.
Thursday, 24th.—Royal Institution, 3. "Recent Discoveries in Egypt," by Mr. R. S. Poole.
—— Royal, 4.30.
—— Philosophical Club, 6.30.
Friday, 25th.—Royal Institution, 8. "Whales," by Prof. Turner, 9.
—— Quekett Club, 8.
Saturday, 26th.—Royal Institution, 3. "Russian Social Life," by Prof. Turner.
—— Physical, 3. "On the Graphical Representation of Musical Intervals," by G. Griffiths. "On a Phenomenon of Molecular Radiation in Incandescent Lamps," by J. A. Fleming.

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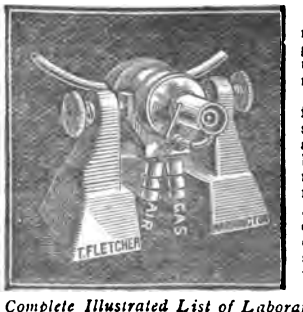

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1226.

ON AN

AMMONIO-PHOSPHATIC DEPOSIT IN THE VICINITY OF CAPE TOWN.

By A. B. GRIFFITHS, F.C.S., &c.

THIS deposit was found some time ago in some caves, a few miles to the south-east of Cape Town, South Africa. The deposit is in a powdered condition, and of a brown colour, but contains solid nodules. These nodules present the appearance of contortions like ordinary guanos; and, when reduced to powder, and washed in distilled water, and the sediment treated with acids, followed by washing in water in the usual way, a microscopical examination showed that these nodules contained a large amount of diatomaceæ, and a few sponge spicules. The powder-deposit also showed the presence of diatomaceæ. On submitting a fair sample of the deposit to analysis, it was found to contain:—70·21 per cent of ammonium compounds, 17·5 per cent of phosphates, 3·3 per cent of nitrogen, &c. Probably these deposits may furnish a very useful manure.

From these observations it is most probable that these deposits consist of the more or less altered excrementitious matters of an extinct fauna.

RE-HYDRATION OF FERRIC OXIDE.

By C. F. CROSS.

I TAKE this opportunity of recording the results of a six months' observation of the re-hydration of the ferric *mono-dehydrate*, using this expression for the composition of the oxide obtained by drying the ordinary precipitate hydrate at 100°.

The specimen used in these experiments lost 9·7 p. ct. on ignition $Fe_2O_3.H_2O = 10·1$ per cent.

The method adopted was that involving the use of the spiral balance, the disposition of the substance, and the mode of weighing in the saturated atmosphere, as described in a previous communication (CHEMICAL NEWS, vol. xliv., 101).

The numbers represent m.m. of extension. The substance was evenly distributed over a circular area of 70 m.m. diameter:—

	A. (1 grm. = 133·5 m.m.)	B. (1 grm. = 135 m.m.)	Time. Hours.	Temp.
May 19	80	70	0	18°
,,	94	82	18	16
,,	94	82·5	23	18
,,	96	84	43	18
,,	96	84	47	20
,, ($Fe_2O_3.3H_2O$)	97	85	67	18·5
,,	97	85	91	18
,,	97	85	115	17
,,	97	86	164	18·5
,,	97·5	86	215	22
,,	97·5	86	264	18
			Days.	
,,	97·5	86	13	18
,,	97·5	86·5	18	19
,,	100·5	88·5	38	18
,,	107	95	57	17
,,	160	145	173	15
Nov. 27 ($Fe_2O_3.11H_2O$)	160	145	192	15

These numbers explain themselves. In order to investigate the stability of this dehydrate, B was exposed to the ordinary atmosphere, and weighed at intervals with the following results:—

B.			Temp.
145	m.m.	After 15 mins. exposure	11°
145	,,	,, 30 ,, ,,	11
145	,,	,, 45 ,, ,,	11
142·5	,,	,, 2½ hours' ,,	11
142	,,	,, 3 ,, ,,	12
141·5	,,	,, 46 ,, ,,	10
141·5	,,	,, 70 ,, ,,	11
142	,,	,, 6 days ,,	10

These numbers express the permanence of the new hydrate and its freedom from hygroscopic water.

The course of re-hydration of ferric oxide is thus an interrupted and extremely gradual progression towards a high limit, which it is perhaps impossible to fix by observation as it would represent the state of equilibrium of a large number of conditions, each difficult of control. It is interesting to notice that a long interruption of the re-hydration occurs at the point $Fe_2O_3.3H_2O$. Parallel with the series A and B, which were conducted in a room with a northern aspect, observations were made with instruments placed in a conservatory with a southern aspect. The results are given under C and D: the conditions were precisely similar to those of A and B.

C. (1 grm. = 125 m.m.)	D. (1 grm. = 129 m.m.)	Time.	Temp.
85	88	0 hours.	22°
94·5	99	18 ,,	20·5
97	101	23 ,,	25·5
94	99	43 ,,	23·5
97	101	47 ,,	28
93·5	98	67 ,,	25·5
94	98·5	91 ,,	19·5
94·5	99	115 ,,	16·5
95·5	100·5	215 ,,	27

The observations were broken off at this stage, as it was found that the large daily fluctuations in temperature caused considerable disturbance from the consequent evaporations and condensations of water, from and upon the portion enclosed in the saturated atmosphere. These results show a lesser rate of progress of the re-hydration under conditions which might be presumed to be more favouracle; and this is their only value. On the other hand, the uniformity of the numbers obtained under A and B is sufficient evidence of the trustworthiness of the method under suitable and regulated conditions.

ON A

NEW TEST FOR DETECTING ALBUMEN IN URINE.

By ARTHUR R. HASLAM.

WHILE recently engaged in some experiments, I had occasion to add a solution of chloride of iron to a diluted solution of albumen, into which, some time previously, a small quantity of chloride of sodium had been thrown. The result was the formation of a dense opaque white precipitate. This precipitate, when well washed and dried, still contained iron, from which circumstance I should suppose it to be a compound of albumen and iron.

I have experimented on this reaction as a test for albumen, especially for that form which it assumes in urine, and it appears certain in its results, and has some advantages in its favour over the old nitric acid test, being much more delicate.

After a series of experiments, I have adopted the following method of using the test:—A portion of the urine

supposed to contain albumen is poured into a test-tube, and a few drops of a solution of chloride of sodium added, and well mixed; then a solution of chloride of iron is carefully poured down the tube, forming a layer. If the appearance of a whitish cone be noticed, albumen is present. If phosphates are present in the urine, care must be taken to add (before using the test) sufficient acetic acid to make the urine acid.

May 19, 1883.

DETERMINATION OF THE CINCHONA ALKALOIDS.

PROLLIUS shakes up 5 grammes powdered bark with a mixture of 38 parts alcohol, 10 parts chloroform, and 2 parts ammonia in a stoppered flask; decants off the liquid after some hours as clear as possible, and mixes them with 5 parts finely powdered hydrate of lime, which at once decolourises the vinous red liquid, whilst the alkaloids remain in solution. The liquid is filtered, weighed, and gradually evaporated, when the quinine remains in a varnish-like state, but the other alkaloids as crystals. The weight of the residue gives the percentage of the bark in alkaloids.

For determining the quinine and the secondary alkaloids soluble in ether, Prollius recommends a mixture of 88 parts ether, 4 parts ammonia, and 8 parts alcohol. Three grms. of powdered bark are digested for some hours with 30 grammes of this mixture, shaking frequently. After the powder has settled, 20 grammes of the solution are decanted clear off, and shaken up with 5 to 6 drops of dilute sulphuric acid, or so much that it slightly predominates. The alkaloids settle to the bottom of the vessel as an acid, thick-flowing, aqueous solution. The ether is decanted off, and the residue of the alkaloids is removed from it by agitation, first with 2 grammes and then with 1 gramme ammonia. The united solutions of the latter are heated to expel the alcohol, and are precipitated, whilst warm, in tared capsules, with ammonia. The precipitate is deposited in a resinous state, and is easily washed and dried.

According to H. Kissel the last-described process is especially adapted for the rapid and accurate determination of the cinchona alkaloids, but it shows not merely the quinine and accompanying bases, but the entire alkaloids in the bark. Kissel macerates the bark with the solvent mixture for two hours, evaporates a clear aliquot part of the solution, re-dissolves the residue with a slight excess of dilute sulphuric acid and hot water, filters from the undissolved wax and quinine acid, precipitates when cold with caustic soda, collects on a tared filter, dries at 115°, and weighs.

J. E. de Vrij admits the advantages of the Prollius process, but modifies it by macerating 10 grammes of very finely powdered bark with 200 grammes of the solvent mixture, shaking up frequently, pours off, and weighs a part of the clear liquid; distils off the ether in a water-bath, and rinses the residue with alcohol into a tared capsule. By drying on the water-bath we obtain the crude alkaloids. These are purified by solution in dilute hydrochloric acid, filtered, and the filter is washed till the washings are no longer rendered turbid by soda-lye. The filtrate is shaken up with chloroform and soda-lye in a separating funnel provided with a stopper and a flask. After twelve hours the stratum of chloroform which contains all the alkaloids is drawn off, the chloroform is expelled by evaporation or distillation, the residue is dissolved in alcohol, evaporated in tared capsules, dried, and the pure alkaloids are weighed.

J. Biel macerates 20 grammes powdered bark with 200 grammes of the solvent mixture for four hours in a well-closed flask, filters rapidly through a folded filter covered with a glass plate, and decolourises the solution, if red, with 20 grammes of finely ground hydrate of lime. One hundred grammes of the filtrate are evaporated to dryness in a beaker on the water-bath, the residue dissolved with a few drops of sulphuric acid and hot water, let cool, filtered, and the filter washed. The total filtrate (about 40 c.c.) is supersaturated with ammonia in a narrow stoppered glass, and four times shaken up with chloroform, using 20 c.c. each time. The chloroform is separated from the aqueous solution by means of a separating funnel, evaporated in the beaker, the residue dried at 110°, and weighed. For accurate determinations the alkaloids must be re-dissolved in dilute acetic acid, filtered through a weighed filter, and the residual resin weighed after drying at 110°, and deducted. The process first given by Prollius yields, according to Biel, the alkaloids in a very impure state, and does not even extract their total quantity.—*Zeitschrift für Analytische Chemie.*

VERY SENSITIVE REACTIONS OF THE SALTS OF IRIDIUM.

By M. LECOQ DE BOISBAUDRAN.

HAVING been recently occupied with the separation of iridium from gallium, the author found the want of distinct characters permitting the identification of traces of iridium carried down by the galliferous products obtained. After many trials he has selected the following reactions, the extreme delicacy of which seems likely to be useful in the analysis of the compounds of iridium:—

(*a.*) The iridium solution (chloride or sulphate) is mixed with an excess of sulphuric acid and evaporated until white fumes are produced. Or the salt of iridium may be at once mixed with an excess of potassium bisulphate. The mass is placed in a gold capsule, heated to dull redness, and kept at that heat for some minutes. If the proportion of iridium is not too great, hot water entirely dissolves the mass, yielding a liquid generally green, but sometimes blue or violet. In concentrated solutions there is deposited, on cooling, a crystalline powder, of a deep green, containing iridium, potassium, and sulphuric acid. This salt, which forms a clear solution with pure water, or water acidulated with sulphuric acid, is precipitated by neutral potassium sulphate.

Without having need to separate the various salts deposited, the liquid is almost neutralised with potassa or ammonia, taking care to keep the liquid cold and leaving it slightly acid to a degree very perceptible to litmus. Much potassium sulphate is precipitated, carrying down with it the larger part of the iridium, and having a pale green colour. The salts are collected on a filter and roughly washed with a solution of neutral potassium sulplate. The liquid and the washings are collected, and on boiling for 15 to 30 minutes, the green, blue, or violet salts of iridium are transformed into a compound, the base of which is completely precipitated, especially on boiling, by an excess of potassa or ammonia, and re-dissolves in dilute sulphuric acid with a rich violet colour, which appears rose in a very dilute solution.

Iridiferous potassium sulphate dissolved in hot water slightly acidified with sulphuric acid gives with potassa or ammonia the same oxide which dissolves in dilute sulphuric acid, with a violet colour.

It is to be remarked that if the boiled liquid is but very feebly acid, the oxide separates out to a very great extent before the addition of alkali. It is then not readily re-dissolved by dilute sulphuric acid, and has to be boiled with this reagent to bring it into solution.

In searching for traces of iridium it is useless to treat separately the iridiferous potassium sulphate. It must be boiled immediately after the approximate neutralisation.

If it is suspected that the process has not been well conducted, if, *e.g.*, the alkaline filtrate has a feeble rose

colour, the liquid is evaporated to dryness, sulphuric acid is added, the whole heated to redness, and treated as above.

In this manner we may separate and detect 1-40th m.grm. iridium (taken in the state of chloride or sulphate) in 50 grms. (two million times its weight) of potassium bisulphate. The precipitation by alkali takes place in a volume of 400 c.c., so that the insolubility of the violet oxide is almost absolute.

For very feeble traces of iridium the violet colour may be masked by the presence of iron salts derived from the filters or the reagents. In this case the solution is neutralised with ammonia, mixed with ammonium hydrosulphate, kept for some time at a gentle heat, filtered, and evaporated almost to dryness. By boiling with aqua regia the ammoniacal salts are destroyed, the sulphur clots together, and the iridium is characterised by the tint of its tetrachloride, the colouring-power of which is decidedly greater than that of the violet sulphate. It is better, however, to apply to the product of the treatment with aqua regia the following reactions *b* and *c*, the sensitiveness of which is extreme.

(*b.*) We add to the salt of iridium (chloride or sulphate) a small excess of sulphuric acid, and heat until a portion of the acid is expelled, so as to drive off the hydrochloric acid—an important point. The capsule is then withdrawn from the fire, and at the moment when the sulphuric fumes cease to be abundant, we add ammonium nitrate in small portions. The capsule is then restored to a moderate fire, and the introduction of the nitrate is continued. There is thus produced a splendid blue colour of such intensity that it may be distinctly obtained with 0·001 m.grm. iridium. When the reaction is complete the capsule is withdrawn from the fire whilst a little of the nitrate is still undergoing decomposition. The blue matter dissolves in water, retaining its colouration.

Sometimes the assay, instead of an indigo-blue, appears of a rich emerald green. It is sufficient to let it cool, drop a little sulphuric acid upon the mass, and heat again, when the colour changes to a pure blue.

An admixture of foreign metals reduces the delicacy of the reaction, which is, however, very useful in presence of gold, ruthenium, platinum, and rhodium. The blue colouration is, of course, modified by the peculiar colourations given by some of the metals subjected to the same conditions. Thus, with a mixture of gold and iridium we obtain a green.

(*c.*) If, instead of expelling the hydrochloric acid by prolonged heating with sulphuric acid, we add at the outset (simultaneously, or rather successively, at short intervals) ammonium nitrate and hydrochlorate, there is formed not the blue matter, but the assay takes a rose colour. An excess of ammoniacal salts destroys, in part, this colour, which reappears on adding a little sulphuric acid and heating. The best process is to throw into the hot sulphuric acid at first ammonium chloride, and shortly afterwards the nitrate, withdrawing the whole from the fire whilst a little of the ammoniacal salts remains undecomposed. The mass on treatment with very little water leaves a rose-coloured powder, soluble in pure water, but insoluble in a saturated solution of ammonium bisulphate. The aqueous liquid appears to contain ordinary ammonium chloro-iridate.

The present reaction can be produced with 0·001 m.grm. iridium.

By combining the process *a* with the reactions *b* and *c*, it is easy to separate and to recognise with certainty 0·01 m.grm. iridium in two million times its weight potassium bisulphate.—*Comptes Rendus.*

Amylic Alcohol produced accessorily in Alcoholic Fermentation.—J. A. Le Bel.—The author concludes that natural grape-juice, when fermented, yields more of the higher alcohols than does sugar.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING APRIL 30TH, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

London, May 5th, 1883.

SIR,—We beg to submit, for the information of the Local Government Board, a statement of the particular and general results of our examination, made at the expense of the Water Companies, of 175 samples of water, collected by us during the past month at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some observations on a portion of the report, made to the Registrar-General, on the water supply of the preceding month.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

To the Secretary of the Local Government Board.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from April 1st to April 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 175 samples of water submitted to examination, the whole without exception were clear, bright, and well filtered; and their condition in respect to aëration and to freedom from colour and excess of organic matter, was unimpeachably excellent.

In the Report to the Registrar-General, on the character of the water supplied to the Metropolis "*during* the month of March," it is asserted that the "Grand Junction and Lambeth Companies' waters were very slightly turbid, and contained moving organisms," the assertion being based on an examination of a single sample of each Company's water taken on the 14th day of the month.

The daily samples submitted to examination by ourselves during the month of March were taken, not as usual from the mains, but on this particular occasion, from the filtered water reservoirs of the companies. Thirty-one samples of each of the inculpated companies' waters were examined by us with all care, and in no one sample were we able to recognise the presence of turbidity or of any "moving organisms."

The Report of the Official Water Examiner, with regard to the supply of the Grand Junction Company during the month of March, is as follows:—"Daily samples were taken at the Works, and the water found to be clear, bright, and efficiently filtered;" while his Report with regard to the supply of the Lambeth Company is as follows:—"Daily samples were taken at the Works, and the water found to be generally clear, bright, and efficiently filtered."

We are, however, quite prepared to admit that among the samples of water, now approaching five thousand in number, examined by us since December, 1880, an occasional sample has been met with in which one or two "moving organisms" were recognisable; but in no case have we found a month's or even a week's supply of any company's water to be chargeable with the presence of "moving organisms."

While not looking upon the occurrence of "moving organisms" in the water supply of a town as otherwise than objectionable, however difficult it may be to ensure from year's end to year's end their absolute exclusion, we think it desirable that the real significance of their presence should not be misunderstood. It seems also to us that in the reports made to the Registrar-General, which not merely set forth the bare analytical results obtained, but profess to explain their import and signification, some statement as to the precise nature of what are so vaguely designated as "moving organisms," and some intimation of their little real importance, might in common fairness be expected from one who, by his persistent use of language which has been reprobated by a Royal Commission, does not a little to create an unfounded prejudice against the water supply on which he is expected impartially to report.

We accept as the expression of our own opinion with regard to "moving organisms" what is stated in the following extracts from a published lecture of Dr. Frankland's, delivered at the Royal Institution in 1861:—"These organisms consist of animalculæ and animals of a larger size. . . . The water supplied to Manchester, which is well known to be one of the best waters in this country, is quite full of this kind of animals in summer. . . . Both of the specimens which I have shown are to be met with in good waters. . . . Looked at from a chemical point of view, they are exceedingly useful in the water. . . . From a physiological point of view, I do not know what sort of a case can be made out against them. . . . The animals themselves cannot pass through the filter, but their ova can."

ELECTRICAL UNITS OF MEASUREMENT.*

By SIR WILLIAM THOMSON, F.R.SS. L. and E., &c.

The Lecturer began by observing that no real advance could be made in any branch of physical science until practical methods for a numerical reckoning of phenomena were established. The "scale of hardness" for stones and metals used by mineralogists and engineers was alluded to as a mere test in order of merit in respect to a little understood quality, regarding which no scientific principle constituting a foundation for definite measurement had been discovered. Indeed it must be confessed, that the science of strength of materials, so all important in engineering, is but little advanced, and the part of it relating to the quality known as hardness least of all.

In the last century Cavendish and Coulomb made the first advances towards a system of measurement in electrical science, and rapid progress towards a complete foundation of the system was effected by Ampére, Poisson, Green, Gauss, and others. As late as ten years ago, however, regular and systematic measurement in electrical science was almost unknown in the chief physical laboratories of the world; although as early as 1858 a practical beginning of systematic electric measurement had been introduced in the testing of submarine telegraph cables.

A few years have sufficed to change all this, and at this time electric measurements are of daily occurrence, not in our scientific laboratories only, but also in our workshops and factories where is carried on the manufacture of electric and telegraphic apparatus. Thus, ohms, volts, ampéres, coulombs, and micro-farads are now common terms, and measurements in these units are commonly practised to within 1 per cent. of accuracy. It seems, indeed, as if the commercial requirements of the application of electricity to lighting and other uses of everyday life were destined to influence the higher region of scientific investigation with a second impulse, not less important than that given thirty years ago by the requirements of submarine telegraphy.

A first step towards the numerical reckoning of properties of matter is the discovery of a continuously-varying action of some kind, and the means of observing and measuring it in terms of some arbitrary unit or scale division; while the second step is necessarily that of fixing on something absolutely definite as the unit of reckoning.

A short historical sketch was given of the development of scientific measurement, as applied to electricity and magnetism, from its beginning with Cavendish, about 100 years ago, to the adoption of the absolute system of measurement by this country in 1869, at the instance of the British Association Committee on Electric Standards. The importance in this development of the originating works of Gauss and Weber was pointed out, as also of the eight years' labours of the British Association Committee. This Committee not only fairly launched the absolute system for general use, but also effected arrangements for the supply of standards for resistance coils, in terms of a unit, to be as nearly as possible 109 centimetres per second. This unit afterwards received the name of the ohm, which was adopted from a highly suggestive paper which had been communicated to the British Association in 1861, by Mr. Latimer Clark and Sir Charles Bright, in which some very valuable scientific methods and principles of electric measurements were given, and a system of nomenclature —ohmas, kilohmas, farads, kilofarads, volts, and kilovolts —now universally adopted with only unessential modification, was proposed for a complete system of inter-dependent electric units of measurement. At the International Conference for the determination of Electrical Units, held at Paris in 1882, the absolute system was accepted by France, Germany, and the other European countries; and Clark and Bright's nomenclature was adopted in principle and extended.

Gauss's principle of absolute measurement for magnetism and electricity is merely an extension of the astronomer's method of reckoning mass in terms of what may be called the universal gravitation unit of matter, and the reckoning of force, according to which the unit of force is that force which, acting on unit of mass for unit of time, generates a velocity equal to the unit of velocity. The universal-gravitation unit of mass is such a quantity of matter, that if two quantities, each equal to it, be placed at unit distance apart, the force between them is unity.

Here mass is defined in terms of force and space, and in the preceding definition force was defined in terms of mass, space, and time. Eliminating mass between the two, it will be found that any given force is numerically equal to the fourth power of the velocity with which any mass whatever must revolve round an equal mass, fixed at such a distance from it as to attract it with a force equal to the given force. And, eliminating force between the two primitive definitions of the universal-gravitation system, it will be found that any given mass is numerically equal to the square of the velocity with which a free particle must move to revolve round it in a circle of any radius, multiplied by this radius. Thus, take a centimetre as the unit of length, and a mean solar record as the unit of time, and adopt 5·67 grammes per cubic centimetre as the mean density of the earth from Baily's repetition of Cavendish's experiment, and suppose the length of the seconds' pendulum to be 100 centimetres, and neglect the oblateness of the earth and the centrifugal force of its rotation (being at the equator only $\frac{1}{289}$ of gravity), the result for the universal-gravitation units of mass and force

* The last of a series of Lectures on the Practical Applications of Electricity, delivered on Thursday Evening, May 3rd, 1883, at the Institution of Civil Engineers.

is respectively 15·36 French tons, and 15·36 dynes, or 15·07 times the terrestrial surface weight of a kilogrm.

The ultimate principles of scientific measurement were illustrated by the ideal case of a traveller through the universe who has brought with him on his tour, no weights, no measures, nor watch or chronometer, nor any standard vibrator or spring balance, but merely Everett's units and constants and a complete memory and understanding of its contents, and who desires to make for himself a metrical system agreeing with that which he left behind him on the earth. To recover his centimetre the readiest and most accurate way is to find how many wave lengths of sodium light there are in the distance from bar to bar of a plating which he can engrave for himself on a piece of glass. How easily this is done, supposing the grating once made, was illustrated by a rapid experiment performed in the course of the lecture, without other apparatus than a little piece of glass with 250 fine parallel lines engraved on it by a diamond, and two candles and a measuring tape of unknown divisions of length (only used to measure the *ratio* of the distance between the candles to the distance of the grating from either). The experiment showed the distance from centre to centre of consecutive bars of the grating to be 32 times the wave length of yellow light. This being remembered to be $5·89 \times 10^{-5}$ of a centimetre, it was concluded that the breadth of the space on which the 250 lines are engraved is 250. 32. 5·892. 10^{-5}, or 0·4726 of a centimetre. According to the instrument maker it is really 0·5 of a centimetre! Five minutes spent on the experiment instead of one, and sodium flames behind fine slits, instead of open candles blowing about in the air, might easily have given the result within one-half per cent instead of 4½ per cent. Thus the cosmic traveller can easily recover his centimetre and metre measure. To recover his unit of time is less easy. One way is to go through Foucault's experimental determination of the velocity of light.

But, he must not be imagined as electrically-minded; and he will certainly, therefore, think of "v," the number of electrostatic units in the electro-magnetic unit of electricity; but he will probably see his way better to doing what he wants by making for himself a Siemens mercury unit (which he can do easily, now that he has his centimetre), and finding (by the British Association method, or Lorenz's with Lord Rayleigh's modification, or both), the velocity which measures its resistance in absolute measure. This velocity, as is known from Lord Rayleigh and Mrs. Sidgwick, is 9413 kilometres per mean solar record, and thus he finds, in mean solar seconds the period of the vibrator, or arbitrary-unit chronometer, which he used in his experiments.

Still, even though this method might be chosen as the readiest and most accurate, according to present knowledge of the fundamental data for recovering the mean solar second, the method by "v" is too interesting and too instructive in respect to elimination of properties of matter from our ultimate metrical foundations to be unconsidered. One very simple way of experimentally determining "v" is derivable from an important suggestion of Clark and Bright's paper, referred to above. Take a Leyden jar, or other condenser of moderate capacity (for example, in electrostatic measure, about 1000 centimetres), which must be accurately measure. Arrange a mechanism to charge it to an accurately measured potential of moderate amount (for example, in electrostatic measure, about 10 c.g.s., which is about 3000 volts), and discharge it through a galvanometer coil at frequent regular intervals (for example, ten times per second). This will give an intermittent current of known average strength (in the example, 10^{2} electrostatic c.g.s., or about 1/300,000 c.g.s. electro-magnetic, or 1/30,000 of an ampere), which is to be measured in electro-magnetic measure by an ordinary galvanometer. The number found by dividing the electrostatic reckoning of the current, by the experimentally found electro-magnetic reckoning of the same, is "v," in centimetres per the arbitrary unit of time, which the experimenter in search of the mean solar second has used in his electrostatic and electro-magnetic details. The unit of mass which he has chosen, also arbitrarily, disappears from the resulting ratio. It is to be hoped that before long "v" will be known within 1/10 per cent. At present it is only known that it does not *probably* differ 3 per cent from $2·9 \times 10^{10}$ centimetres per mean solar second. When it is known with satisfactory accuracy, an experimenter, provided with a centimetre measure, may, anywhere in the universe, rate his experimental chronometer to mean solar seconds by the mere electrostatic and electro-magnetic operations described above, without any reference to the sun or other natural chronometer.

The remainder of the lecture was occupied with an explanation of the application of the absolute system in all branches of electric measurement, and the definition of the now well known practical units founded on it, called ohms, volts, farads, microfarads, amperes, coulombs, watts. The name mho, found by saying ohm to a phonograph and then turning the drum backwards, was suggested for a unit of conductivity, the reciprocal of resistance. The sub-division, millimho, will be exceedingly convenient for the designation of incandescent lamps.

The British Association unit has been found by Lord Rayleigh and Mrs. Sidgwick to be 0·9868 of the true ohm (10^{9} centimetres per second), which differs by only 1/50 per cent from 0·9870, the number derived from Joule's electrothermal measurements described in the British Association Committee's report of 1867, with 772 Manchester foot-pounds taken as the dynamical equivalent of the thermal unit from the measurement described in his Royal Society's paper of 1849, and confirmed by his fresh measurement of twenty years later, published in his last Royal Society paper on the subject.

It is satisfactory that, whether for interpreting old results, or for making resistance-coils anew, electricians may now safely use the British Association unit as 0·9868, or the Siemens unit as 0·9413, of the ohm defined as 10^{9} centimetres per second.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 17, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—T. H. Coleman, B. Hobbs, B. P. Lascelles, M. F. Purcell, W. R. Reffell, D. Wilson.

It was announced that a ballot for the election of Fellows would be held at the next meeting of the Society on June 7.

The PRESIDENT then called on Capt. W. de W. ABNEY, F.R.S., to deliver a lecture "*On Photographic Action studied Spectroscopically.*"

The Lecturer said that he wished all chemists to become photographers, for photography occupied the border-land between chemistry and physics. The days had been long past when black fingers were a necessary concomitant of photography. At the present time there was a vast number of amateur photographers, but there were but few who studied the scientific aspect of photography. By most experimenters it was looked upon as a servant to be abused rather than used, and the majority were content with working by rule-of-thumb. The Lecturer was firmly impressed with the fact that photographic action is inter-atomic. He had already shown in a previous paper that throughout the absorption spectra of a series of organic compounds the absorption due to hy-

drogen could be recognised. Something of the same kind seems to occur in inorganic chemistry.

Probably the first photographic action with which most chemists become acquainted is the blackening of chloride of silver by light. Now if this salt be perfectly dry, and perfectly free from organic matter, &c., it will not blacken when exposed to light. Two tubes were exhibited, both of which had been exposed for some time to the action of light: in one the chloride was quite white; in the second the chloride, which was moist, had blackened.

The action of developers was then discussed. A picture on iodide of silver paper, which had been previously exposed, was developed before the meeting, with gallic acid and solution of silver nitrate. The action of the light is to liberate free iodine, and the developer precipitates metallic silver to form the image; the number of particles acted on by the light must be extremely small. The image can be washed off with nitric acid, and a fresh picture taken on the same film. A second image was developed with citrate and oxalate of iron; in this case the metallic silver must have been obtained from the film itself. Some other experiments were shown, proving the truth of this statement: Development is not a chemical but a physical action.

It was found on photographing the solar spectrum that the amounts of energy in different parts were very varied and irregularly distributed; recourse was had to the positive pole of the electric arc light. The incandescent light had not sufficient energy, but the positive pole furnishes a spectrum which has sufficient energy, and is much more uniform than the solar spectrum. For producing the spectrum everyone would probably first choose the diffraction grating, but it was found that a perfect grating did not exist, and one grating differed so much from another, owing to minute differences in the ruling, that eventually a glass prism was adopted, as the grating could not be relied on for quantitative work.

Films of chloride, bromide, and iodide of silver were successively interposed in the beam of the electric lamp, and it was shown that the chloride partially cut off the violet end of the spectrum, the iodide absorbed the whole of the violet, but the bromide cut off part of the blue as well as the violet. An image of the spectrum was then thrown on films containing respectively silver chloride, bromide, and iodide, and the plates were developed with ferrous oxalate. It was seen that with the chloride but a small portion of the spectrum had acted on the silver salt, and that with the bromide a very much longer image was obtained.

The action of sensitisers was next considered. The part played by a sensitiser is the taking up of the chlorine, bromine, and iodine set free by the action of light. To demonstrate this action, an image was thrown on to a sensitive plate, and during the exposure a streak was made across the plate with a solution of sodium sulphite. On developing, a black stripe indicated the position of the sodium sulphite, this salt having rendered the silver salt in its vicinity more sensitive. A sensitiser is useless unless it be close to the salt on which it is to act, so all sensitisers are more or less hygroscopic, or they may act in solution or as vapour. Almost any organic compound acts as a sensitiser.

The Lecturer then gave instances of coloured sensitisers, and photographs of the spectrum were taken on films coloured with cyanin-blue and with eosin. The plates were developed, and the relation between the portion of the spectrum photographed and the portion absorbed by these pigments demonstrated. Thus cyanin-blue absorbs the yellow, and the photograph of the spectrum on the film coloured with cyanin-blue exhibits a band in the yellow where the absorption had been previously seen. It is very remarkable that one salt of silver may act as a sensitiser to another salt of silver. Thus a film containing bromiodide of silver photographs much more of the spectrum than two films containing the one bromide and the other iodide.

It is easy to destroy the results of photographic action. If a film during exposure be washed with any oxidising agent, as potassium permanganate or bichromate, dilute nitric acid, peroxide of hydrogen, &c., the image is completely effaced. Thus, if plates which are foggy from accidental exposure be dipped in dilute bichromate of potash and well washed, they are restored to their original condition. This bleaching effect was demonstrated by throwing a picture on a sensitive plate, and during exposure making a streak with bichromate solution across the plate. On developing, this streak was seen to be white. A sensitive plate, after exposure to light, was soaked in dilute nitric acid, containing 1 drop of acid in 8 ozs. of water, and then exposed to the spectrum; the tendency of the nitric acid was to oxidise. At the violet end where the reducing power of the light was at its maximum this tendency was overcome, but the red end was perfectly white. A method of obtaining a reversed image was demonstrated. A sheet of iodised paper was exposed to light, then immersed in potassium bromide solution. A picture was then thrown on it; on developing, it was found to be reversed.

An instructive experiment was also shown of an easy means of preventing the bad results of over exposure. An extremely sensitive dry plate was soaked in sodium sulphite solution, and exposed for sixty seconds to a bright spectrum. On developing, a good picture came out, not in the least reversed. So a picture cannot be reversed if some substance is present in the film having a great affinity for oxygen.

A beam of light was transmitted through films of the three varieties of silver bromide. The ordinary variety was orange; the film used in the gelatin dry plates, a sort of French grey; the film used for photographing the ultra-red portion of the spectrum, green.

In conclusion the lecturer said he had endeavoured to point out to the chemists present, some of the pitfalls which beset the practice of photography.

The PRESIDENT, in proposing a hearty vote of thanks to Captain Abney, said that all must feel that they had had a great scientific treat. Most chemists had dabbled in photography, and must have felt how many points required investigation. He hoped that Capt. Abney would continue his researches, and he was sure that no one was more able to carry them out to a successful issue.

The vote of thanks was passed by the crowded meeting with acclamation, and the Society adjourned to June 7, when a ballot for the election of Fellows will be held, and the following paper read:—"Laboratory Notes," by Dr. Gladstone and Mr. Tribe: "1. On the Action of Light and Heat on Cane- and Invert-Sugar; 2. On Hydroxylamin; 3. Recovery of Iodine from Organic Iodide Residues; 4. A Residual Phenomenon of the Electrolysis of Oil of Vitriol; 5. On an Alleged Test for Alcohol; 6. Reaction of the Copper-zinc Couple on Nitric Oxide; 7. On the Reducing-action of Spongy Lead.

Separation of Copper and Zinc by Sulphuretted Hydrogen.—E. Berglund.—The author, after discussing the failure of various authorities in effecting this separation, gives the following direction, which he has found sufficient:—The mixed solution of metallic salts (sulphates or chlorides) are concentrated so as to contain about 5 m.grm. metal per c.c. The solution may be more dilute, but not more concentrated. To the liquid is then added 1-5th volume of hydrochloric acid of sp. gr. 1·10, and it is then precipitated with sulphuretted hydrogen in moderate excess. The precipitate of copper sulphide is immediately filtered off, washed first with dilute hydrochloric acid containing sulphuretted hydrogen (10 to 20 vols. sulphuretted hydrogen water to 1 vol. hydrochloric acid), and then with dilute sulphuretted hydrogen water (1 vol. saturated sulphuretted hydrogen water to from 100 to 120 vols. water. The confirmatory analyses are satisfactory.—*Zeitschrift für Analytische Chemie.*

NOTICES OF BOOKS.

Materia Medica: a Manual for Students. By ISAMBARD OWEN, M.D. London: J. and A. Churchill.

THE author, in his Preface, does not claim for his book the rank of an original or complete treatise on *Materia Medica*. He intends it rather as a supplement to than as a substitute for the systematic work, and seeks "to aid students by placing the outlines of the subject before them in such a manner that they may be clearly grasped and readily committed to memory." It is of course highly desirable that the student should "clearly grasp"—is there not here a slight confusion of metaphor?—the principles of his subject. But committing to memory savours somewhat of cram.

The work, however, possesses the valuable properties of clearness and brevity in an eminent degree. Some ingenuity would be required to find a superfluous word, and a still higher amount to misinterpret the descriptions and instructions given.

Under the carbo-hydrates we notice the statement that beet-sugar is precisely the same compound as cane-sugar,—a view which is becoming more and more questionable. Bees, at least, can perceive a difference.

Logwood is stated to be a native of the East and West Indies. We most strongly doubt the former locality, and in the latter it seems to have been introduced from Central America.

Otherwise, we see nothing in the book to which reasonable exception may be taken, and think that it is well adapted to the end in view.

OBITUARY.

THE LATE DR. JAMES YOUNG.

THE death of this distinguished industrial chemist has excited a regret by no means confined to scientific circles. Dr. James Young was born in Drygate, Glasgow, in 1811. His elementary education was received at a parochial school in the neighbourhood. We next find him assisting his father in his business as a carpenter. But an inbred scientific instinct led him to attend the evening lectures on chemistry delivered at the Andersonian Institution by Thomas Graham, F.R.S., afterwards Master of the Mint. His abilities and his enthusiasm for science attracted the notice of Professor Graham, who, in 1832, gave him the position of assistant in his laboratory, first in Glasgow and afterwards at University College, London. This position he filled with credit to himself and satisfaction to his employer until 1839. He was next appointed manager at the extensive alkali works of Messrs. Muspratt, at Newton in the Willows, Lancashire. His managership was, as we happen to know, eminently successful, not merely as regards the quantity and quality of the product, but in the difficult task of avoiding nuisance and injury to neighbouring estates. In 1843, his connection with the Muspratts terminated, and he occupied a similar position at the chemical works of Messrs. Tennant, at Manchester. Here he greatly extended his experience, and here he devised an original and elegant process for the manufacture of stannate of soda. Instead of taking metallic tin as his starting-point, he fluxed the ore with soda, thus saving a number of expensive manipulations. Whilst at Manchester he formed the acquaintance of Dr., now Sir Lyon Playfair, at that time Professor of Chemistry in the Royal Institution of that city. By him Young's attention was drawn to a spring of petroleum which had been discovered in Derbyshire. He at once undertook the utilisation of this new product, and obtained from it both an illuminating oil and a lubricant. When the oil-well ceased flowing, Young undertook the task of obtaining an artificial petroleum by the regulated distillation of certain carboniferous shales. In this attempt he succeeded, the chief products of the process being the well-known paraffin oil, and the almost equally celebrated solid paraffin, or "paraffin wax." By these inventions the cost price of light in all places where gas is not available was greatly reduced. It was even found that for many purposes a well-trimmed paraffin lamp was superior to gas, as burning more steadily and giving off no sulphurous acid. Fortunately, whilst largely benefitting his country and the world at large, Mr. Young, unlike certain meritorious inventors, reaped a well merited reward for his skill and perseverance. The competition of the American native petroleum of course tended to reduce the value of paraffin oil. But if the oil wells of Pennsylvania, as many believe, have seen their most productive days, the distillation of oil shales has an immense future in prospect. We cannot help here noticing that certain attempts have been made to depreciate Young's merits by insinuating that the principles of his patented process were previously known. But if known they were dormant. Young alone gave them practical life and utility, and created a novel and a most important industry. In carrying out his operations at Bathgate, he was associated with Mr. Meldrum, formerly of Alfreton, and Mr. Binney, F.R.S., of Manchester, the eminent geologist. One of his earliest materials was the famous "Torbanehill mineral," which involved him in a tedious and complicated lawsuit. He had acquired a lease of coal underlying certain lands, and under that lease was working the mineral in question. The lessors of the land contended that the Torbanehill mineral was not coal, and brought an action to restrain him from working it. Almost all the foremost chemists and geologists of the day were called to decide the question, and contradicted each other in an unedifying manner. The case was ultimately compromised as incapable of decision. But the general opinion now is that scientific evidence was here out of place. The mineral at issue was capable of subserving the uses to which coal is commonly put, and might, therefore, justly be regarded as coal from a business point of view. Mr. Young erected another and larger manufacturing establishment at Addiewell, and continued the business at both until it was ultimately turned over to the large limited liability company by which it is still conducted. Mr. Young has been no less distinguished for his public spirit and munificence than for his eminence as a technical chemist. He founded some years ago at the Anderson Institute, now known as the Anderson College, a Chair of Industrial Chemistry, and endowed it with fifteen thousand guineas. He caused a bronze statue to be cast of his early friend and patron, Thomas Graham, and presented it to his native city, where it now forms one of the chief ornaments of St. George's Square. At his own expense and in collaboration with Dr. Angus Smith, Mr. Young collected together into one large handsomely-printed volume of over 650 pages all Graham's memoirs, and presented copies to the friends of Graham and to chemists in various parts of the world.

When working in Graham's laboratory, he formed the acquaintance of David Livingstone, who was then employed during the day at a cotton mill. The friendship which sprung up between them was terminated only by death. Young had even sent out an expedition to relieve and rescue the great African traveller, but the news of his death caused its return without having accomplished anything.

It will not, we hope, be considered impertinent if we suggest that some public honour should be done to the memory of a man who has deserved so well of Science, of his country, and of the world.

The Transmission of Sound by Gases.—M. Neyreneuf.—The author finds that the law of Hawksbee is not exact.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 18, April 30, 1883.

Pyro-electricity of Quartz.—C. Friedel and J. Curie.—A critique of the results of M. Hankel.

A Quaternary Base derived from Oxy-quinoleine.—A. Wurtz.—The author finds that oxy-quinoleine may unite with ethylene hydrochlorate to form an oxy-ethyl-oxy-quinoleine, $C_{11}H_{12}NClO_2$.

Use of a Doubly-Refractive Glass in certain Operations of Spectral Analysis.—M. Cruls.—The use of a doubly-refractive crystal in certain researches of spectral analysis seems to the author to offer decided advantages. He hopes shortly to describe an apparatus which he names the polarispectroscope.

Analogy between the Allotropic States of Phosphorus and of Arsenic.—R. Engel.—The author has previously shown that whenever arsenic is liberated from one of its compounds at a temperature below 300°, it is obtained in an allotropic state. According to the text-books arsenic sublimes at 180°; this is inaccurate. Crystalline arsenic kept for some hours in an inert gas at a temperature bordering upon 360°, or for eight hours in a vacuum, does not sublime. Crystalline arsenic, therefore, is not volatile below 360°. Amorphous arsenic begins to sublime in a vacuum at 260°, and in an inert gas at 280° to 310°. The sublimation is rapid, but it stops after some hours. The residue is no longer capable of sublimation, even at 360°; its density has become 5·7; in a word, the amorphous arsenic has been transformed. This difference between the temperatures at which the two states of arsenic sublime is very well marked. Amorphous arsenic is transformed below 360° (about 310°) if the action of the heat is sufficiently prolonged. Amorphous arsenic resembles white phosphorus, whilst crystalline arsenic resembles red phosphorus. Red phosphorus crystallises, and its crystals are isomorphous with those of arsenic. The density of red phosphorus is higher than that of white phosphorus, just as that of crystalline arsenic is higher than that of the amorphous kind. White phosphorus, like amorphous arsenic, sublimes at a temperature lower than that at which it is transformed. Red phosphorus, like crystalline arsenic, is not sublimable at this temperature. The vapour given off by red phosphorus yields white phosphorus when cooled below the temperature at which transformation takes place, just as the vapour of crystalline arsenic gives amorphous arsenic below 300°.

A Process for Hardening Soft Calcareous Stones by Means of Silico-fluorides having a Base of Insoluble Oxides.—L. Kessler.—The author criticises the use of alkaline silicates for hardening building stones, and recommends, in preference, magnesium, aluminium, zinc, or lead silico-fluorides, which, if applied in a few layers, produce great hardening, whilst no soluble compound is formed by the reaction.

Researches on the Metallic Derivatives of the Amides. Means of Distinguishing a Mono-amide from a Di-amide.—H. Gal.—In a former paper the author has shown that by the reciprocal action of zinc-ethyl and of a non-saturated amine, there is liberated ethyl-hydride, whilst the zinc takes the place of the hydrogen in the amine employed. With the amides similar results are obtained. The author has studied the action of zinc-ethyl upon the amides of the fatty series; those of the aromatic series and upon the di-amides. The action of zinc-ethyl upon the amides is very different, according as a mono-amide or a di-amide is present. In the former case two molecules of the compound intervene, but only one in the second. Hence by causing zinc-ethyl to react upon substances of imperfectly known constitution, but which may be connected with the amides, we may, from the results obtained, determine the class to which they belong.

A Means of Foreseeing the Escape of Fire-damp.—B. de Chancoutrois.—The author recommends that continuous observations should be made in coal-mines with the seismograph.

No. 19, May 7, 1883.

Very Sensitive Reactions of the Salts of Iridium.—Lecoq de Boisbaudran.—This paper will be inserted in full.

Specific Heats of Certain Gases at Elevated Temperatures.—M. Vieille. The mean specific heat of the gases,—carbon monoxide, nitrogen, hydrogen, and oxygen—for constant volumes, varies by, at most, two-thirds of its value between 0° and 4400°.

The Electric Dynamograph or Apparatus for Registering the Work of Machines.—C. Resio.—The author has devised an apparatus which registers automatically, a curve of which the ordinates are proportional to the effort applied to the motor axle, and the abscissæ proportional to its angular velocity. Consequently, the area comprised between any two ordinates, the curve, and the axis of the abscissæ, shows the work of the machine in the time in which the diagram has been traced.

A Fundamental Point of Theory of the Report presented by M. Cornu.—G. Cabanellas.—A mathematical paper, not capable of useful abstraction.

Archives Neerlandaises des Sciences Exactes et Naturelles, Tome xvii., Part 4.

Thermo-chemical Researches on Ozone.—E. Mulder and H. G. L. van der Meulen.—Admitting that the combination-heat of one affinity of an atom of oxygen with an affinity of another atom of oxygen is always the same, both in ordinary oxygen and in ozone, we are led to the formula O—O--O for ozone, because in $3(O=O)$ and $2\left(\begin{matrix}O-O\\ \diagdown\diagup\\ O\end{matrix}\right)$ there are twelve affinities which neutralise each other two and two. Consequently, in the transformation of ordinary oxygen into ozone there can be absorption of heat, whilst experience proves the contrary. The authors consider that the structure O—O—O is rendered probable by the slight stability of ozone; $\begin{matrix}O\\ \diagup\diagdown\\ O-O\end{matrix}$ would indicate greater stability. The fact that neither heat nor light, but merely electricity, can transform ordinary oxygen into ozone is explained, because the gaseous molecules charged with different electricities may arrive temporarily at a state of rest, which is favourable to the attraction of the molecules and the atoms. Not only there have been speculations put forward—especially of late—on the manner in which the elements may be constructed, but attempts have been made to penetrate experimentally to their structure. But it is known that we cannot for the present indicate a single fact which obliges us to admit that an element, and in like manner an atom, may be disintegrated by the means which science at present possesses. It is even little probable that electricity at its maximum tension could dissect an atom. As far as the authors are aware the following hypothesis has not yet been announced, though its value is naturally very relative:—It is that the so-called atom may be regarded as the atom of the first order, con-

structed of atoms of the second order, which are in turn composed of atoms of the third order, and so on to infinity. This hypothesis does not exclude the unity of matter. According to this view the atom is infinitely complex, and every attempt to obtain a complete knowledge of matter clashes with the impossibility of making an infinite series of experiments.

Researches concerning Electro-magnetic Dispersion on a Spectrum of Great Extent.—W. C. L. van Schalk.—Not suitable for useful abstraction.

Tome xviii., Part 1.

Electro-magnetic Rotation of the Plane of Polarisation.—W. C. L. van Schalk.—This important memoir requires the accompanying illustrations, and is otherwise incapable of useful abstraction.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 2, 1883.

A New Method for the Volumetric Determination of Phosphoric Acid in Superphosphates.—A. Mollenda.—Inserted in full.

Contributions to the Analysis of Wine (Continuation).—Dr. J. Nessler and Dr. M. Barth.—In this section the authors discuss the determination of the free tartaric acid. They adopt the following modification of the process of Berthelot and Fleurien:—Two portions of the sample, each of 20 c.c, are taken; to the one are added 4 drops (0·15 to 0·2 c.c) of a 20 per cent solution of slightly acid potassium acetate, and each is then mixed with 100 c.c. of alcohol-ether, well shaken, and allowed to stand in a stoppered flask for at least eighteen hours in a place not warmer than 10°. The precipitate, after filtration, is dissolved in a small quantity of water at a gentle heat, and the solution is titrated with vigintinormal alkali. In strongly plastered wines the accurate determination of free tartaric acid has not been effected. The authors treat further of the determination of sugar, gum arabic, fixed and volatile acidity, of tannin in white wines, and of glycerin in sweet wines.

Determination of Total Sulphur in Coal-gas.—Theodor Poleck.—This paper cannot be usefully reproduced without the accompanying illustration showing the apparatus.

A New Method for Determining Sulphur in Organic Bodies.—Peter Claesson.—This memoir will be inserted in full.

The Quantitative Determination of Traces of Silver.—C. F. Föhr.—This paper will be inserted in full.

Determination of Nicotine in Tobacco.—R. Kissling.—The author refers to a previous memoir on this subject, defends his method against the renewed criticisms of Skalweit, examines the modifications proposed by the latter, and replies to Prof. Dragendorff.

Comparative Determinations of Sugar according to the Methods of Fehling and of Sachse, and to the Polarimetric Principle.—Dr. B. Haas.—The author concludes that in ordinary impure glucose the polarisation process constantly gives too high a percentage of sugar, the error being sometimes very considerable. Though in many cases concordant results can be obtained by the methods of Fehling and of Sachse, this does not always occur, and the discrepancies are often important. For determining sugar, both in impure glucose and in wine, Fehling's solution is unquestionably preferable to that of Sachse.

Determination of Chlorine in Liquids containing dissolved or suspended Organic Matter, and possibly Sulphur Compounds.—Dr. F. Muck.—The liquid is evaporated nearly or quite to dryness, the residue moistened with a sufficiency of caustic soda or potassa, free from chlorine, heated, and solution of permanganate is added until the green colouration is permanent. Alcohol is then added drop by drop till the green colour disappears; alcohol and aldehyd are driven off, the liquid is filtered, and the residue is washed with hot water.

Copper Hydroxide.—Dr. Julius Loewe.—The author contends for the stability of his preparation, in answer to Soxhlet.

The Detection and Determination of Lactic Acid.—R. Palm.—If a solution of basic lead acetate is mixed with an excess of ammoniacal alcohol (Dzondi's liquor), 1 part to 5 or 6, and if aqueous lactic acid is added, the more concentrated the better, there is formed a white amorphous precipitate, the lactic acid being entirely deposited as lead lactate. The most convenient way of operating is to add ammoniacal alcohol to a mixture of basic lead acetate and lactic acid so long as a precipitate is formed. Lead lactate is soluble in excess of water, in acetic and lactic acids, and in caustic alkali. In quantitative determinations the precipitate is therefore washed with alcohol. One grm. lead lactate, dried at 100°, contains 0·788 lead oxide.

Certain Reagents for Vegetable Alkaloids.—R. Palm.—This paper will be inserted at length.

Detection of Free Sulphuric Acid in Presence of Organic Acids.—W. Bachmeyer.—The author prepares a red test-paper by dipping pure filter-paper, free from acids, into moderately strong extract of sapan-wood, and lets it dry. This paper keeps good for months if light is excluded. Slips of this paper are plunged for about half a minute into the liquid under examination, and allowed to dry slowly in the air. If sulphuric acid is present in quantity, not less than 1 part by volume in 500, the entire slip, or its edges, when perfectly dry, takes a fine peach-blossom colour. A comparative experiment with a similar liquid free from sulphuric acid removes all doubt. As in most cases a gradual concentration of the liquid on the water-bath to one-fifth of its original bulk is permissible, 0·04 per cent by measure of sulphuric acid can be thus detected. The reaction is especially useful in the examination of wine and vinegar. It must be remembered that free nitric and hydrochloric acids produce the same results as sulphuric acid.

Tap for Store-bottles of Distilled Water, Aspirators, &c.—Josef Sobieczky.—The author's arrangement cannot be understood without the accompanying cut.

Determination of Phosphoric Acid and Magnesia.—R. Ulbricht.—The author lays prior claim to the method described by Dr. Broockman in the *Zeitschrift* for 1882, p. 551.

Albuminoid Bodies in Milk.—Leo Liebermann.—The author points out that he has anticipated the results published by Dr. E. Pfeiffer on p. 14 of the present volume (see *Liebig's Annalen*, 181, p. 90).

A Procedure for Qualitative Analysis by means of the Microscope.—H. Reinsch.—The author prepares a dilute solution—about 4 per cent—of the substance in question, allows a drop to evaporate on a slip of glass, and examines the residue under the microscope, fitted with a polarising apparatus. A previous acquaintance with the appearance of the substances sought for, and an acquaintance with microscopic work are necessary.

Spectroscopic Anomalies.—L. Palmieri.—When mixed chlorides are introduced into the flame, the spectral lines of one alone are apt to appear. The spectrum of copper chloride is not visible, except in large excess, in presence of sodium chloride. In a mixture of iron, sodium, lithium, and potassium chlorides, the spectra of the three latter only are visible.

A Source of Error in Polarisation.—A. Hölzer.—Coloured liquids give discrepant rotations, both by daylight and lamp-light. The influence of colour is insignificant if the monochromatic soda-light is used.

An Automatic Gas Closer. — H. Michaelis.— An apparatus for turning off a current of gas at any required time. The principle is that of an alarum clock.

Improvement in Water-drying Ovens heated by Gas.—E. Seelig.—The arrangement cannot be described without reference to the diagram.

A Modification of Erdman's Float.—A. Gawalowski. —Instead of a line engraved on the outside of the float the author fixes a slip of black paper horizontally in the inside. The upper edge of the paper can be seen more sharply than an engraved line.

Absorption of Hydrogen by Palladium.—H. Tschirikoff.—The author utilises this reaction for absorbing hydrogen given off in operations conducted in sealed tubes.

Filter-paper washed with Hydrochloric and Hydrofluoric Acid. — This process was recommended some time ago by P. Townsend Austen, and is now carried out on the large scale by Schleicher and Schull. The tenacity and closeness of the paper are not injured, and the proportion of mineral matter is reduced so low that it may be neglected even in accurate analyses.

The Volumetric Determination of Alumina.—A. von Reiss.—The solution is mixed with ammonia to neutralise free acid, slightly acidified with acetic acid raised to a boil, and there is added some calcium chloride. If the solution contains sulphuric acid the calcium chloride must be added in such quantity that no precipitate of calcium sulphate is produced. A standard solution of ammonium oxalate is then gradually added, keeping the liquid at a boil, and observing when a distinct turbidity appears, which marks the end of the reaction. Three equivalents ammonium oxalate consumed indicate one equivalent alumina.

Determination of Chromium as Chromic Oxide.— A. Souchay has shown that if chromium hydroxide is precipitated with ammonia in glass vessels, the results are always too high. Th. Willm confirms the statements of Souchay. In precipitating with ammonia or ammonium sulphide, he obtained errors in excess up to 6 per cent. These differences depend entirely on the use of glass vessels.

Volumetric Determination of Zinc with Potassium Ferrocyanide.—According to M. Galletti, before titrating zinc with ferrocyanide, manganese must be removed. C. Fahlberg, on the other hand, maintains that manganese has no disturbing influence. R. W. Mahon has re-examined the question, and finds that, contrary to the statements of Fahlberg, zinc and manganese are both precipitated by ferrocyanide, and that an increased addition of acid is not able to prevent the precipitation of manganese. If zinc has to be titrated with ferrocyanide in manganiferous zinc ores, Mahon recommends that the ammoniacal liquid remaining after removal of the metals of the 5th and 6th groups and of iron, should be distinctly acidified with acetic acid, precipitated with sulphuretted hydrogen to separate zinc from manganese. The precipitate of zinc sulphide is then well washed, dissolved in hydrochloric acid, and the solution used for titration.

Determination of Cobalt and Nickel.—E. Fleischer. —Already inserted from the *Journal fur Praktische Chemie.* E. Donath proposes the following modification:—The solution containing the two metals is halved. In the one half both metals are precipitated by boiling with potassa or bromine, whilst in the other half the cobalt alone is thrown down as a sesquioxide by boiling with potassa and iodine; a saturated solution of iodine in potassium iodide. The determination of the sesquioxide in each of the two precipitates is effected iodometrically by boiling the precipitates in a suitable apparatus with hydrochloric acid, receiving the chlorine evolved in solution of potassium iodide, and titrating the liberated iodine with decinormal sodium hyposulphite. As 1 equiv. iodine represents 2 equivs. of cobalt or nickel (the atomic weights of each being equal), the difference of the c.c. of decinormal hyposulphite consumed in the two titrations, multiplied by 0·0059, gives the weight of the nickel, and the number of c c. used in the second operation, likewise multiplied by 0·0059, shows the weight of the cobalt.

Volumetric Determination of Lead, Zinc, Copper, and Mercury.—C. A. M. Balling.—The author submits the sulphides of these metals to prolonged ebullition with a solution of silver nitrate and sodium acetate. In case of the sulphides of the three former metals, a measured quantity of a silver solution of a known strength is employed, and in the filtrate the excess of silver nitrate is titrated with potassium sulphocyanide. The difference between the quantity of silver originally employed and that remaining in the filtrate is equivalent to the metal in question. In case of mercury sulphide the silver sulphide formed is filtered off, well washed, dissolved in nitric acid, and the quantity of silver is determined volumetrically with potassium sulphocyanide.

Volumetric Determination of Copper and Lead.— The method of Pelouze is open to the objection that the end of the reaction is not easily recognised. F. Mohr and C. Künzel (*Journal Prakt. Chemie*) have already sought to overcome this difficulty. Paul Casamajor proposes the following modification:—He mixes the solution of copper in a porcelain vessel with an excess of alkaline solution of potassium-sodium tartrate (prepared by dissolving 173 grms. of the double tartrate in 480 c.c. soda-lye, of sp. gr. 1·14, and making up to 1 litre), heats almost to a boil, and adds sodium sulphide until a drop no longer occasions turbidity. If the solution is well stirred it collects at the bottom of the vessel so completely that the supernatant liquid appears clear, and the slight turbidity occasioned by the last drop is distinctly visible.

Determination of Copper as Copper Oxide.—To obtain copper as a finely granular precipitate, easy to wash, W. Gibbs recommends to mix the dilute solution, containing not more than 1 gramme copper per litre, with alkaline carbonate in a slight excess, and to boil for half an hour to ensure complete precipitation. To avoid the prolonged boiling and the "bumping" of the liquid, F. P. Dunnington gradually adds a slight excess of sodium carbonate to the boiling dilute solution of copper, and then a dilute solution of caustic soda till the precipitate blackens. The precipitate subsides quickly, and can be completely washed by five or six decantations with hot water.

Detection of Sulphurous Acid.—B. Reinitzer.—The author points out that Bödeker's process for detecting sulphites along with hyposulphites by means of sodium nitro-prusside is wrongly described in the text-books. They direct the liquid to be acidified with acetic acid, whilst Bödeker expressly states that the reaction is sensitive only in neutral solutions, or such as contain sodium bicarbonate.

Indirect Determination of Chlorine and Bromine. —L. P. Kinnicutt.—Instead of converting the mixture of silver chloride and bromide entirely into silver chloride by heating in a current of chlorine, or reducing it in a current of hydrogen, the author effects the reduction galvanically.

Detection of Fusel Oil in Alcohol.—Jorissen recently proposed to mix the alcohol with colourless aniline oil and a little hydrochloric acid, when the presence of fusel oil is shown by a splendid red colouration. K. Förster shows that this reaction is due not to amylic alcohol, but to the furfurol always present in crude fusel oil. This fact, however, does not affect the practical value of the test.

Alkaloids of the Cinchona Barks.—In addition to the analytical researches recently given in the *Zeitschrift*, the editors refer briefly to a number of investigations of newly-discovered alkaloids, and on properties of the alkaloids already known not directly applicable in analysis.

A Reaction of Morphine.—E. Grimaux.—From the *Comptes Rendus.*

Reactions of Quinoline.—Julius Donath and H. Hager describe the behaviour of the salts of this base with reagents. Their results do not always agree.

Behaviour of Saccharine with Silver Oxide.—H. Kiliani.—On heating saccharine with silver oxide and water, carbonic acid is evolved, and there are formed formic, glycolic, and *acetic* acids. If dextrose and levulose are similarly treated there is formed *oxalic* acid in place of acetic.

Determination of Bromine in Organic Substances.—H. Schwarz.—The author proposes the following modification of Brügelmann's process:—The substance is weighed in a porcelain boat. The tube is filled as follows, beginning at the end where the oxygen enters:—A layer of platinised asbestos, the boat with the substance, an empty space, a layer of platinised asbestos 15 c.m. in length, a long and a short boat with pure sodium carbonate. To the other end is attached a Varrentrapp-Will bulb-tube filled with water. The ignition is so heated that the platinised asbestos remains white. The absorption boats containing sodium carbonate must be heated only moderately so that no sodium bromide may be volatilised. The author prefers, however, Volhard's titration process as more certain. (See *Zeitschrift*, xvii., p. 482, and xviii., p. 271).

Analysis of Organic Platinum Double Chlorides.—O. Wallach.—The salt to be analysed is weighed in a platinum capsule, covered with a fresh prepared solution of ½ to 1 gramme soda in absolute alcohol: the excess of alcohol is expelled by gently heating upon the water-bath until a crystalline scum appears; the capsule is then set upon a triangle, and the alcohol is set on fire by means of the gas-flame. The platinum salt is decomposed, forming metallic platinum and sodium chloride, whilst the organic matter is consumed. When the flame of the alcohol goes out the capsule is heated for some time with a lamp. When cold the contents are treated with water and nitric acid, filtered, and the chlorine in the filtrate is determined with silver nitrate. The filter with its contents are returned to the capsule, and ignited till the filter and the carbon of the organic matter are consumed. The residue is then weighed for the determination of the platinum.

Determination of Phenol.—The method of E. Waller is taken from the Chemical News, and that of Chandelon from the *Bull. de la Soc. Chim. de Paris.*

The Proportion of the Reductive Powers of Tannin and Oxalic Acid with Solution of Permanganate.—C. Councler and J. Schroeder.—If the reductive power of oxalic acid is 63, that of tannin = 34·2 or 34·3. Neubauer, in earlier experiments, obtained the proportion 63 : 41·57.

Separation and Determination of Picrotoxine — R. Palm.—Picrotoxine is completely thrown down from its ammoniacal solutions by basic lead acetate, and may be obtained in a state of purity by treating the precipitate with hydrogen sulphide, filtering off the lead sulphide, and evaporating the filtrate. If fatty acids are present they are precipitated from the ammoniacal solution by means of baryta before throwing down the picrotoxine with basic lead acetate.

Examination of Air.—J. Reiset, A. Muntz, and E. Aubin.—No particulars are given.

Water Analysis.—J. W. Mallet.—A criticism on the methods in common use. The combustion method of Frankland and Armstrong gives results which cannot be regarded as an accurate determination of the organic carbon and nitrogen present in water. The carbon is always, and often considerably, too low, and the organic nitrogen frequently too high. Nevertheless, the method gives the organic carbon more accurately than the permanganate process, and the organic nitrogen more accurately than that of Wanklyn. This method gives both the free and the albumenoid ammonia too low, sometimes notably so, and the distinction between these two forms of nitrogen is not always distinctly marked. The results of the permanganate process (Tidy's form) gives results which vary irregularly from those obtained in boiling liquids according to Kubel's form. In no case is the quantity of permanganate consumed which would be required for the complete oxidation of the organic matter.

On the Composition of Secondary Wines (Wines obtained by allowing a solution of sugar to ferment upon the grapes after pressing).—A Girard.—From the *Moniteur Scientifique* (series 3, xii., p. 895).

Detection of Starch in Sausages.—C. Amthor.—The author dissolves out fatty matter with ether and converts the starch into glucose by treatment with diastase.

Examination of Chocolate.—E. Herbst.—The author determines moisture, fatty matter, sugar, and ash. A small addition of oil of sesame, which is said to be common, cannot be recognised with certainty. Organic adulterations are sought for with the microscope.

Determination of Neutral Fats in Mixtures of Fatty Acids.—Max Gröger.—From 4 to 8 grms. of the sample are placed in a flask holding 300 c.c. and dissolved by heating to a gentle boil in 50 c.c. alcohol at '96° Tralles. A few drops of phenol phthaleine are added, and the liquid is mixed with semi-normal alcoholic solution of potassa till the red colour no longer disappears on shaking. It is then diluted with 150 c.c. water, shaken well up when cold with 60·100 c.c. ether, allowed to settle, and the clear solution of soap underlying the ethereal stratum is drawn off as completely as possible, but so that nothing of the ethereal liquid is taken away. It is largely diluted with water, and boiled till the alcohol and ether are expelled. The fatty acids are then liberated by the addition of dilute sulphuric acid, washed with hot water till the washings have no longer an acid reaction, let cool, and the equivalent weight of the carefully dried fatty acids are determined by titrating a weighed quantity with semi-normal alcoholic potassa.

Determination of Oil of Mustard in Rape Cake.—G. Ulex.—The author macerates the sample with lukewarm water for half an hour, distils until the distillate no longer smells of mustard; shakes it up with bromine (free from sulphuric acid), expels excess of bromine by heat, decolorises the liquid with ammonia, acidifies with hydrochloric acid, filters, and precipitates with barium chloride; 233 parts barium sulphate represent parts oil of mustard.

MEETINGS FOR THE WEEK.

Monday, 28th.—Society of Arts, 8. Cantor Lectures. "Secondary Batteries and the Electrical Storage of Power," by Prof. Oliver J. Lodge, M.A., F.R.S.

Tuesday, 29th.—Institution of Civil Engineers, 8.

—— Society of Arts, 8. "Queensland: its Progress and Resources," by Arthur J. Stanesby.

—— Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.

Wednesday, 30th.—Society of Arts, 8. "The Relative Claims of Etching and Engraving to rank as Fine Arts," by F. Seymour Haden, F.R.C.S.

Thursday, 31st.—Royal Institution, 3. "Recent Discoveries in Chaldæa and Assyria," by Mr. R. S. Poole.

—— Royal, 4.30.

—— Society of Arts, 3. Prevention of Fires. (Public Meeting.)

—— Royal Society Club, 6.30.

—— Chemical, 8. Ballot for the election of Fellows. "Laboratory Notes:—On the Action of Light and Heat on Cane and 'Invert' Sugars; On Hydroxylamine; Recovery of Iodine from Organic Iodide Residues; A Residual Phenomenon of the Electrolysis of Oil of Vitriol; on an Alleged Test for Alcohol; Reaction of the Copper-Zinc Couple on Nitric Oxide; On the Reducing Action of Spongy Lead;" by Dr. J. H. Gladstone and Alfred Tribe.

Friday, June 1st.—Royal Institution, 8. "The Sword," by Prof. F. Pol ock, 9.

Saturday, 2nd.—Royal Institution, 3. "Russian Social Life," by Prof. Turner.

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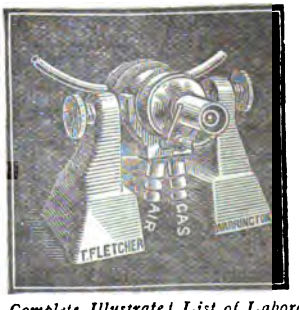

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1227.

NOTE ON THE ATOMIC WEIGHT OF BERYLLIUM.*

By J. EMERSON REYNOLDS, M.D., F.R.S.

IN the course of a paper by Professor Humpidge on the above subject, recently read before the Society,† the author seeks to decide between the atomic weight 9·2 for beryllium, resulting from my comparison of the atomic heat of the element with that of silver and aluminium,‡ and the value 13·8, arrived at by MM. Nilson and Pettersson by determination of specific heat ||. The difference between the two possible atomic weights is so small, and the difficulties met with in attempting to prepare even a few decigrms. of beryllium are so great that both sets of experiments have been objected to on the ground, amongst others, that the metal employed was in all cases impure. My specimen admittedly contained a minute quantity of platinum, and the proportion of known impurity in one of MM. Nilson and Pettersson's specimens reached 13 per cent. Unfortunately, Professor Humpidge's metal, though claimed to be the purest yet prepared, is shown by analysis to be rather less pure than one of the specimens employed by Nilson and Pettersson; hence the experiments lately made known to the Society do not carry the inquiry beyond the point previously reached, save in one noteworthy particular, namely, that there appears to be a considerable, though irregular, rise in specific heat of the element as the proportion of impurity diminishes; though the value is still much below that required for the atomic weight 9·2. Thus, for a specimen of beryllium which contained 13 per cent of *known* impurity, Nilson and Pettersson obtained the specific heat 0·4084 between 0° and 100° C., and for a less impure specimen 0·425; while Professor Humpidge, in one of his experiments, with a material that contained 6 per cent of impurity, found the specific heat to be nearly 0·45 (0·4497). In all these cases corrections were applied which were believed to eliminate the effects due to the impurities known to be present—in part mechanically mixed with the metal and partly alloyed with it.

These results all tend in one direction, that is to say, to apparent gain in specific heat with increased purity of material, and in so far they approach the still higher value obtained in my old experiments. But even if the latter had not been made, the apparent rise in specific heat shown by the other experiments would suggest the necessity for appeal to data afforded by beryllium of undoubted purity. In order that further experiments should now be considered decisive, the metal should not only be pure, but in the form of a homogeneous mass obtained by fusion, as the specimen I used was an apparently uncrystalline product of fusion, while the metal employed by Nilson and Pettersson chiefly consisted of "aggregations of little prismatic needles," mixed with the oxide.

The most promising source of pure beryllium is the double fluoride of the element and potassium, but I have not hitherto succeeded in making the product by reduction from a button of metal.

Professor Hartley has very recently made known some highly interesting, spectroscopic evidence§ affecting the position of beryllium amongst the metals, and so directly bearing on the question of its valence that I may be permitted to refer to the results in this place.

If the atomic weight of beryllium be 13·8, the element is a triad and the formula of its oxide must be Be_2O_3. It therefore resembles alumina in being a sesquioxide, but is at once distinguished as it does not form an alum-like double sulphate, as do alumina and its homologues, and has comparatively little in common with that group, save the tendency to form highly basic salts. Nilson and Pettersson,* admitting this, maintain that beryllium is a leading member of another group of triads, which includes the rare earth-metals scandium, yttrium, lanthanum, didymium, terbium, erbium, &c. The recent spectroscopic evidence above referred to is opposed to this contention, as the spectrum of beryllium is stated to be wholly unlike the spectra afforded by the rare earth-metals with which it is classed in the memoir above cited. If, then, beryllium does not find a place in the two known families of metallic triads, it must stand alone; and in any case as a triad it is outside Mendeleef's classification. But if the atomic weight of beryllium be 9·2, according to my result, the metal is a diad, and the symbol for its oxide is BeO. It is, therefore, the first member of Mendeleef's second series of elements. This position is quite in accordance with the spectroscopic evidence obtained by Professor Hartley, from which it appears that "beryllium is the first member of a diad series of elements, of which in all probability calcium, strontium, and barium are homologues."

* A Paper read before the Royal Society, May 24, 1883.
† Read April 12, 1883.
‡ CHEMICAL NEWS, vol. xxxv., p. 124, and vol. xlii., p. 273. A slight modification of this method by comparison adopted is described in detail in this writer's "Experimental Chemistry" (Longmans), Part I, p. 59.
|| *Proc. Roy. Soc.*, vol. 31, p. 37.
§ In a communication read before the Chemical Society, April 19, 1883.

APPLICATION OF ORGANIC ACIDS TO THE EXAMINATION OF MINERALS.†

THIRD PAPER.

By Professor H. CARRINGTON BOLTON,
Of Trinity College, Hartford, Conn.

37. IN the two papers previously published under the same title‡ we have shown that citric acid has a power of decomposing minerals little less than that possessed by hydrochloric acid, and that the organic acid can be advantageously employed in field-work for assistance in determining species. In the second of these papers we stated that the results obtained by the *prolonged* action of citric acid on minerals differed greatly from those recorded in the accompanying tables, and gave notice of our intention to return to the subject at a subsequent period. We have continued our researches, and gained a few additional facts which we deem of sufficient interest to warrant a third or supplementary paper on the subject.

The results given in the tables|| were obtained by acting on the minerals in fine powder; first, in the cold for a few hours, and secondly, at a boiling heat for a few minutes. We find, however, that many species which resist the brief action of a boiling concentrated solution of citric acid are more or less completely decomposed by prolonged contact with the same solution at the ordinary temperature of the work-room, say 60° to 70° F. But a small number of the two hundred minerals embraced in the tables were submitted to the prolonged action of the acid solution, and those tested were selected as representative of groups, sulphides, oxides, silicates, &c. The progress of decomposition was noted at various periods from a few days to more than two years. A solution of citric acid concentrated in the cold was used in all the experiments.

38. *Sulphides.*—Chalcocite showed signs of decomposi-

* *Proc. Roy. Soc.*, vol. 31, p. 50.
† Read before the American Association for the Advancement of Science, Montreal Meeting, August, 1882.
‡ CHEMICAL NEWS, vol. xxxvi., pp. 249 *et seq.*; also vol. xliii., pp 31 *et seq.*
|| *Ibid.*, p. 40.

tion at the end of ten days, and at the expiration of several months yielded a partial solution of a pure green colour.

Ullmannite showed signs of decomposing in two days, and afforded in a month a very dark-coloured solution.

Arsenopyrite was attacked in a few days. Pyrite showed decided evidence of decomposition in eight days; one month later the solution acquired a reddish yellow colour, and reacted for iron and sulphuric acid.

Chalcopyrite acts similarly, the solution being of a greenish yellow hue, and reacting for copper and sulphuric acid. One gramme of the mineral lost about 11 per cent of its weight after fourteen months' contact with the acid solution. In general quantitative experiments were not conducted, for it soon became clear that the amount of decomposition was proportionate to the time, and would require more attention than the results to be gained warranted.

Smaltite was decidedly attacked after eight days; the presence of sulphuric acid in the coloured solution was noted. Tetrahedrite was strongly attacked in about four months. Cinnabar, orpiment, argentite, and pyrargyrite resisted the acid solution altogether.

39. *Oxides.*—The experiments recorded in this brief supplement were made with only those minerals which resisted the acid solution on boiling; and since it was obviously useless to test such bodies as quartz, corundum, rutile, &c., only the three oxides of iron remained of this class for examination.

Magnetite and limonite were strongly attacked in eight days; hematite yielded much more slowly, showing decided decomposition after several months.

Exposure to sunlight, as might be expected, diminished the intensity of the coloured iron solutions.

40. *Silicates.*—Of the silicates examined datolite is by far the most quickly decomposed by the acid solution; after twenty-four hours it yields gelatinous silica. Datolite should probably be transferred from column H of the Tables to column D.*

Hornblende, pyroxene, almandite, epidote, vesuvianite, and serpentine were decidedly decomposed in eight days; after one month hornblende, almandite, and epidote yielded coloured solutions and slimy silica, and serpentine gave gelatinous silica. After fourteen months' contact with the acid solution (occasionally agitated) the hornblende and pyroxene were very completely decomposed, the solutions having a dark brown colour and full of floating silica. Actinolite seems to be less easily decomposed than common black hornblende. The serpentine after fourteen months yielded a dry gelatinous mass.

The felspars are very unequally attacked under similar conditions. Labradorite yields the easiest, decomposition being noticed after eight days, and slimy silica forming in the course of some months. Orthoclase and oligoclase showed marked signs of decomposition after eight months, but albite is doubtful. Tourmaline and staurolite yielded to the acid after four or five months, the latter forming a solution coloured by iron and slimy silica. Talc and kyanite appear to resist the action of citric acid.

Muscovite and biotite yield very slowly, the latter showing signs of decomposition the sooner. After two years' subjection to the acid solution very minute scales of mica separate, and some slimy silica appears in the slightly coloured liquid.

41. We have detailed these simple observations somewhat minutely because we believe they have an important bearing on geological disintegration and erosion. At the Saratoga meeting of the American Association for the Advancement of Science my friend Dr. Alexis A. Julien presented an exhaustive summary and analysis of all known observations, concerning the geological action of the humus acids.† In this paper he notes the negative character of the results I had obtained with a number of minerals, *e.g.*, pyrite, augite, hornblende, the felspars, micas, &c., and says—"But the nature and strength of the solvent employed and the brief duration of each trial seem at present insufficient to justify generalisations, notwithstanding the suggestiveness of certain results." My subsequent observations have confirmed his views. Generalisation is still of doubtful value, yet we are tempted to make the venture. In the following Table we have arranged the chief rock-forming minerals, with a few of their associates, under four heads indicating their relative disintegration by citric acid; the position of each mineral is of course only approximate, and it is not intended to indicate that all the species in one column are equal in degree of their decomposition. The application of this Table to the consideration of geological phenomena is a subject which I do not venture to discuss: if we have a right to assume that the disintegrating effect of the acids of humus differs from that of the other organic acids in degree rather than in kind, the Table may prove a small contribution to chemical geology.

TABLE

Showing approximate relative Disintegration of Rock-forming (and Associated) Minerals by Citric Acid in Solution.

Quickly Decomposed.	Slowly Decomposed.	Very slowly Decomposed.	Not Decomposed.
Carbonates	Serpentine	Orthoclase	Quartz
Phosphates	Pyroxene	Oligoclase	Corundum
Prochlorite	Hornblende	Albite (?)	Spinel
Chrysolite	Labradorite	Biotite	Beryl
Nephelite	Garnet	Muscovite	Fluorite
	Epidote	Tourmaline	Barite
	Vesuvianite	Staurolite	Talc (?)
	Pyrite	Hematite	Kyanite (?)
	Limonite		
	Magnetite		
	Gypsum (?)		

* See Tables in CHEMICAL NEWS, vol. xliii., pp. 40 and 41.

† *Proceedings Am. Assoc. Adv. Sci.*, Saratoga Meeting, vol. xxviii., p. 311, 1879.

DETECTION OF ANHYDROUS GLUCOSE MIXED WITH REFINED CANE-SUGAR.*

By P. CASAMAJOR.

I LATELY received from Chicago a sample of sugar suspected of being adulterated. The appearance of this sugar, and the sensation to the touch, were decidedly in favour of the supposition that starch-sugar had been mixed with it. The sensation to the touch is very characteristic of such mixtures. The person who sent the sugar described this sensation by saying that "it felt like ground cocoa-nut."

Upon applying to the suspected sugar several tests, which had been found efficacious in detecting common hydrated starch glucose, the following results were obtained:—

A test which was described before this Society at its meeting of March, 1880,† consists in stirring a suspected sugar with a small quantity of water. If any ordinary commercial starch glucose is present this will appear as chalky white specks, which are distinctly seen in the translucent mass of wet sugar. This test is worthless with crystallised anhydrous glucose, as the crystals of this substance have, when mixed with water into a paste, the same translucency as crystals of cane-sugar.

I also applied to the suspected sugar the test which consists in treating a sample of sugar with a saturated solution of starch glucose in methylic alcohol of density equal to 50° of Gay Lussac's alcohometer.‡ In the present instance the saturated glucose solution which I used was made from anhydrous dextrose. By washing the

* Read before the American Chemical Society, February 2, 1883

† *Journal of the American Chemical Society*, vol. ii., p. 111.

‡ *Ibid.*, p. 428.

suspected sugar with this solution a small crystalline residue was obtained, which could not represent the total glucose present, as there was only 5 per cent, a quantity too small to pay for the trouble of mixing it with refined sugar.

The crystalline residue, placed under a microscope, showed the elongated square prisms characteristic of anhydrous glucose, a form which cannot be mistaken for crystals of cane-sugar, and still less for the thin plates of hydrated glucose.

Before proceeding with accounts of further tests, I must here withdraw a suggestion made by me before this Society in November, 1880,* to the effect that starch glucose, mixed with refined cane-sugar, could very likely be determined quantitatively by washing the suspected sugar with a saturated solution of starch glucose in methylic alcohol, and then weighing the residue. I suggested this process as one that might succeed, but one which I had not had occasion to try. The results which I have since obtained with this process show that the residue is much less than the quantity of starch-sugar originally present. This is undoubtedly owing to this, that after dissolving cane-sugar, the methylic solution acquires the property of dissolving additional quantities of starch sugar.

The sample of suspected sugar was also tested by the optical saccharometer. The direct test was 93·7 per cent. The solution was inverted, giving as a result 74·5 per cent of pure sugar. This result clearly showed adulteration by a dextro-rotatory substance. It does not, however, represent the actual quantity of cane-sugar present, as I will show, by examining the influence of anhydrous glucose in a case of this kind.

To study this influence I took 26·048 grammes of anhydrous glucose, which were dissolved in sufficient water to give 100 c.c. of solution. A portion of this being placed immediately in the tube of the saccharometer gave a deviation of 115·4 to the right. After standing in the tube for twenty minutes the deviation fell to 95·7; after two hours the deviation was 82·5. It was then allowed to stay over-night in the tube, and, fourteen hours after, the deviation had fallen to 78·8, which did not vary afterwards on standing for several hours. The solution was then heated to 68° C. with 10 per cent of its volume of hydrochloric acid, the operation taking about fifteen minutes.

This, after being neutralised with carbonate of soda, gave a deviation to the right still equal to 78·8. There had then been no change by treating with hydrochloric acid, which shows that the presence of dextrose is no bar to obtaining correct results by inversion, provided both observations, before and after inversion, are made after the deviating power of dextrose has reached a state of rest.

Returning to the test of the suspected sugar by the optical saccharometer, we have seen that the deviation to the right was at first 93·7 per cent. After standing in the tube fifteen minutes the deviation fell to 90·2. We have seen that the result obtained by inverting, after the first reading, was 74·5. This result is evidently too high, as the dextro-rotatory power of the dextrose present had diminished in the interval between the two observations.

Another sample of adulterated sugar was placed in the saccharometer as quickly as was practicable, after dissolving it in water. The indication was 100·4 per cent. As this sugar had all the appearance of a low sugar this indication was sufficient to show that it was adulterated. This solution was kept in the tube for further examination. Fifteen minutes afterwards the deviation had fallen to 94·3 per cent. Half-an-hour from the first observation, the reading was 91·6; one hour after, 90·2; two hours after, 89·9; three hours after, 89·7; five hours after, 89·3. After this there was no further variation. After inversion the indication was 72·7 per cent, which was considered as the correct percentage of pure sugar.

The optical saccharometer may, then, be considered as sufficient to determine if starch glucose is present in a sugar, by observing the deviation immediately after getting the solution ready for the saccharometer, and repeating the observation at sufficiently wide intervals of time. If dextrose is present in notable quantities the deviation will decrease in a marked manner. Although the proof obtained in this way is satisfactory, it can only be applied by the very few persons who have saccharometers. To combat adulteration the best processes are those which can be easily applied by dealers and consumers who are unprovided with scientific appliances.

The following process can be applied by using such means as are at the command of everybody. It is applicable to the detection of adulteration with either anhydrous or hydrated glucose:—

Take two beaker glasses or two tea-cups. In one put a quantity of the suspected sugar, and in the other put about the same quantity of a sugar known to be refined sugar, free from adulteration.

Add, cautiously and gradually, a quantity of water to each sugar sufficient to make each equally and decidedly moist, and stir the sugar to mix it well and get it uniformly wet. Then place both cups in hot water. Any temperature between 50° and 100° C. will do. In about ten minutes the pure sugar will appear more moist than when cold, while the other sugar, if it contains a sufficient amount of starch glucose, will have sunk into a pasty, sticky mass, analogous to the *fill mass* of sugar refiners.

The application of heat is not indispensable, as a difference may be obtained by allowing the two sugars to stand several hours after being moistened, but with heat the effect is immediate, and is much more marked.

If the two samples of sugar are allowed to stand in the cups after they have cooled down, the pure sugar will look drier on becoming cold, while the adulterated sugar will continue in the state of a pasty, sticky mass.

This test is founded on the property possessed by cane-sugar to form viscous uncrystallisable compounds when mixed with many organic or inorganic substances, among which are anhydrous and hydrated dextrose. An example of compounds of this kind is *molasses*, obtained as a residuum in sugar manufacture.

As long as a mixture of cane-sugar and starch-glucose is sufficiently dry it may look fair enough, as the elements which form molasses are kept from combining by want of water. The sugar adulterator is well aware of this, and he is careful to dry his sugar before mixing with glucose. Indeed, one characteristic of adulterated sugars is that they are always drier than refined sugars of the same grade, which are known as *coffee sugars*, and are always sold moist.

As soon as sufficient water is added to an adulterated sugar, and moderate heat is applied, enough viscous syrup is formed to make the sugar sink into a paste, which remains permanently soft.

Useful indications may be obtained as to adulteration by starch-glucose, by means of Fehling's solution. An ordinary refined coffee sugar will rarely show more than 5 per cent of glucose, while a sugar adulterated with the usual dose of starch glucose will show about 20 per cent of glucose.

* *Journal of the American Chemical Society*, vol. ii., p. 429.

DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.

By E. AGTHE.

FROM 0·5 to 1 gramme of the specimen, according to the quantity of phosphorus supposed to be present, is dissolved in 50 c.c. nitric acid; the solution is evaporated to dryness, the residue strongly heated, and afterwards—in order to expel the last trace of nitric acid—it is evaporated down again with hydrochloric acid. It is then re-dissolved in hydrochloric acid; so much hot water is added that

the silica may separate out; the solution is filtered into a porcelain capsule, and evaporated on the sand-bath at a high temperature as long as everything dissolves on shaking the capsule. It is then further evaporated as far as possible at a lower temperature; but no firm, solid, crusts must be formed. This evaporation must be conducted with especial care: if a little too much hydrochloric acid remains unevaporated the result will be too low, but if hard crusts are formed a clear solution cannot be obtained with nitric acid.

When cold, 35 c.c. ammonia of sp. gr. 0·96 are added and stirred up with a glass rod, so that a thick paste is formed. 75 c.c. nitric acid of 1·2 sp. gr. are then added; the capsule is set in a warm place and stirred to promote solution. The solution is rinsed into a beaker, and when no longer too hot, from 50 to 100 c.c. molybdic acid added, well stirred; the beaker set in a warm place (not above 80° for four hours, let cool, filtered, and washed with dilute molybdic solution. The washed precipitate is dissolved upon the filter in a minimum of ammonia, and the ammoniacal solution is mixed with hydrochloric acid till the precipitate formed re-dissolves with difficulty. When the beaker is quite cold, 15 to 25 c.c. magnesia mixture are added; the whole is well stirred, filtered after standing for six hours, slightly washed with ammoniacal water, dried, ignited, and weighed. The filtrate from the ammonium phospho-molybdate is mixed with ammonia, and set for four hours in a warm place, observing if a further yellow precipitate is formed. If this is the case the analysis is defective; the liquid is then neutralised as far as possible with ammonia, more molybdic solution is added, and the second precipitate is weighed along with the former.

The author prepares his molybdic solution by dissolving 115 grammes molybdic acid in 460 ammonia at 0·96 sp. gr., adding 1 litre water, and pouring this solution into nitric acid of sp. gr. 1·2. The liquid is let stand for a day and filtered.

For magnesia-mixture he takes magnesium chloride 101·5 grms., ammonium chloride 200, liquid ammonia 400 grms. (sp. gr. 0·96), and water 1 litre.—*Zeitschrift für Analytische Chemie.*

VOLUMETRIC DETERMINATION OF FERROCYANOGEN IN CRUDE PRUSSIATE.

By J. TCHERNIAC.

The author employs a saturated solution of potassium permanganate; a standard solution of the same salt, of which 1 c.c. corresponds to 1 decigrm. of potassium ferrocyanide; and a solution of ferrous sulphate containing 50 to 100 grammes per litre.

A measured quantity of the solution in question, containing about 3 grms. ferrocyanide, is made up to 500 c.c. with sulphuric acid in a thin measuring flask, and mixed with so much of the saturated permanganate that the red colour does not disappear after agitation for some minutes. The whole is allowed to stand for about half an hour: after the oxidation is complete caustic soda is added in large excess, and the whole is heated to a boil, with constant stirring. The hot solution is mixed with so much ferrous sulphate that the precipitate is coloured black by the ferroso-ferric oxide liberated, let cool, filled up to the mark, and filtered. In an aliquot part of the filtrate (250 c.c.) the quantity of the ferro-cyanogen reformed by the ferrous sulphate is determined by titration with the standard permanganate, after acidulation with sulphuric acid.

In case of mother-liquors containing 15 per cent or less of potassium ferrocyanide, 10 c.c. are poured into 70 c.c. of alcohol at 95 per cent, to which a little acetic acid has been previously added. The precipitated ferrocyanide is washed with alcohol at 90 per cent until the washings are neutral, dried at 100° on the filter, dissolved in water, and titrated with permanganate solution.—*Zeitschrift für Analytische Chemie.*

DETERMINATION OF TOTAL TARTARIC ACID IN CRUDE TARTAR, &c.

Exactly 3 grammes of the finely ground sample are mixed in a small beaker with 30 to 40 c.c. water and 2 to 2·5 grammes potassium carbonate, and boiled for ten to twenty minutes, constantly stirring. The acid potassium tartrate and the tartaric acid combined with calcium are thus converted into neutral potassium tartrate. The whole is introduced into a measuring cylinder or flask holding 100 c.c., cooled, made up to 100 c.c., shaken up, and after standing for some time, filtered through a dry filter into a dry flask. 50 c.c. of the filtrate are then evaporated down to about 10 c.c., mixed with 2 c.c. glacial acetic acid, and from 100 to 120 c.c. of alcohol at not less than 95 per cent. To effect the complete separation of the bitartrate, the whole is well stirred for some time, and after standing is filtered. The residue is washed with alcohol at 95 per cent until the washings which run off after dilution with water no longer show an acid reaction. The moist precipitate, together with the filter, is returned to the capsule, stirred up with water, heated to a boil, and titrated with normal soda. The number of c.c. consumed multiplied by ten gives the percentage of hydrated tartaric acid in the sample.—*Zeitschrift fur Analytische Chemie.*

ON ALGIN: A NEW SUBSTANCE OBTAINED FROM SOME OF THE COMMONER SPECIES OF MARINE ALGÆ.*

By EDWARD C. C. STANFORD, F.C.S.

The utilisation of hitherto waste materials presents a large field for chemical investigation, and many important industries have within the last twenty years resulted from such researches.

There are few materials so abundant, so general, and so easily obtained as the commoner kinds of sea-weed thrown up on all our coasts, but especially on those exposed to the waves and storms of the Atlantic. The species I refer to—the laminaria and fuci—are found growing on all rocky shores. And it may also be remarked that, except as manure, the great bulk of this material has been long practically unutilised. It is true that, when burnt into the rough slag known as kelp, this material was formerly the means of securing large revenues to the proprietors of the western islands. For several well known reasons, that manufacture has long ceased to be profitable, and it never could have been considered as utilising the sea-weed, except in the sense that burning down a forest could be called utilising it, when it ought to be cut into timber and really utilised in building houses or making furniture.

In 1862 the writer introduced a method of carbonising the sea-weed in retorts, and thus converting the material into charcoal instead of kelp, and preventing the great loss of iodine arising from open-air burning. This was simply another step of improvement, and comparing it again with the forest, was merely equal to making the timber into charcoal instead of burning it into ash. It is not, in a proper and fuller sense, utilising the sea-weed. The results of further attempts in this direction form the subject of this paper. When we remark that the present widespread destitution and want of employment amongst the

* Read before the Chemical Section of the Glasgow Philosophical Society, April 2, 1883.

poor cottars is most severe in just those districts in Ireland and the Highlands where this material is most abundant, the importance of this inquiry will be at once seen. Indeed, if a remunerative price can be paid for a waste material that every child in a large family can easily assist in collecting at their own doors, it would go far to settle many existing difficulties, of which the worst is always hunger. And this brings me to mention the value of the algæ as a food material. In my paper read before the Society of Arts in 1862 on "The Economic Applications of Sea-weed," the various kinds so used were described, and I have called attention more recently, in a paper read before the Chemical Society, to the fact that the analysis of the charcoal obtained from the various algæ approximates more nearly to that of a product of the animal than of the vegetable kingdom. I believe the algæ generally to be quite as valuable food products as the fungi, with the advantage that we are unaware of any poisonous species. Both are, however, equally neglected in this country. As the edible fungi are much consumed by other European nations, so the edible algæ are largely enjoyed and realise a high price in China and Japan. A sample of one of the Japanese varieties before us yielded on analysis a composition closely similar to our laminaria. It has, however, evidently been cut up, and presents the appearance of long shreds, aud is coloured green by the action of an alkali. The poor people in Donegal are now eating the Fucus vesiculosus with Indian meal, and it is a common thing to see the Highland cattle browsing on this plant at low tide. The Aliaria esculenta or murlins, of which a fine specimen is on the table, may be called our edible species, but the Rhodomenia palmata, or dulse, is perhaps better known in Glasgow, being regularly sold in the streets.

The most important species consumed in this country is the Chondrus crispus or Irish moss. This plant contains 79 per cent. of carageenin, a substance of great gelatising power, and largely used in jellies and puddings. This sea-weed would, no doubt, secure a considerable market as a size for fabrics, but it cannot be obtained in any great quantity. It is only uncovered at low spring-tides, and any very large demand would soon exhaust the supplies. A recent application of Irish moss is being worked by a limited company under the name of velo-plastic, which is said to be made of refuse leather, dried and finely ground and mixed with caragheenin. I am indebted to Mr. John A. Walker, of Dublin, for specimens of green and yellow morocco, poplin, and satin damask, and watered silk, all of which appear to be most successful imitations. The new substance to be described in this paper would probably answer equally well for this application.

Another still more powerful gelatising substance is gelose. This was first imported into France from China in 1856. It has ten times the gelatising power of isinglass, and will set into a jelly 500 times its weight in water. It is not nitrogenous, and contains—Carbon, 42·8; hydrogen, 5·8; oxygen, 51·4. It has not superseded isinglass for jellies, as the fusing-point of the jelly is too high to melt in the mouth. I found some years ago, in experiments on every variety of sea-weed that could be procured, that this gelatising principle was confined to two British species—the Chondrus crispus and the Gelideum cornenu. An Australian alga, the Euchemia spinosa, or agar agar, is also a jelly-yielding species. Several articles have recently been introduced under various names, such as thao, fucyne, &c., all of which appear to be modifications of, or products from, these plants.

The application of sea-weed as manure is very general where it can be obtained. In fact the practical value placed on it is far above its actual chemical valuation. It usually contains 80 per cent. of water, so that four tons of water are carted to the land for every ton of dry sea-weed, and even when dried there is not a large saving in carriage, and it is then very bulky. It is, however, carried long distances *in some* places, and there is no doubt that it is very valuable on soils that are all sand; but it is more of a mechanical value, as its use is not to *manure* but to *make* the soil—a rather expensive manufacture. Kelp waste—a ton of which, dry, represents 40 tons of wet sea-weed, and contains all the phosphates of the weed in a convenient form—is absolutely unsaleable to farmers in this country at any price.

The only other important proposed application of sea-weed has been to the manufacture of paper, and about 20 years ago several patents were taken out with this object, and some specimens were exhibited at the Society of Arts on the occasion before referred to. They were all made, however, from the Zostera marina, or grass wrack—a marine plant with flowers growing in the sea, but not one of the algæ— and this plant makes a very good paper. It created a good good deal of attention at that time, having been proposed as a substitute for cotton during the cotton famine. It is not, however, available in large quantity, and contains very little fibre. The algæ generally contain no fibre, but, as far as my experiments have gone, nearly every species yields a very pure cellulose, which makes a tough, rather transparent paper. The tissue of the plant consists of simple cells of various shapes laid end to end, and in the fuci containing a dark pigment. This cellulose fabric, which forms the paper material, amounts, when quite dry, to 10 per cent. of the air-dry plant. In working on the fuci and laminaria, my attempts to make a paper pulp were much impeded by a peculiar substance common to both these species, which was found at first difficult to remove, and the presence of which rendered the paper brittle. In fact this appeared to be always the case unless the cellulose was obtained quite pure. This substance is present in large quantities, and forms the bulk of the plant.

Any one observing the long flat fronds of the laminaria after the salts are removed lying on the sea shore must have noticed two things—1st, that these are easily bleached by exposure to light; 2nd, that, after exposure to rain, the fronds contain in their interior sacs of fluid. These are derived from the endosmosis of the water through the outside membranes, dissolving a peculiar glutinous principle. Upon opening one of these sacs, a neutral, glairy, almost colourless liquid escapes. Sometimes it may be seen partially evaporated on the surface of the frond as a jelly-like substance, which may be drawn out by the fingers in long, tenacious strings. This fluid contains a unique substance of remarkable properties, and to which, from its source, I have given the name of algin. The vesicles are only seen in the long fronds of the various laminaria, especially L. Henophylla, known in the Highlands as bardarrig, or red-top. The large stems or tangle, and the fuci, although containing it in considerable quantities, do not exhibit this appearance.

If the liquid be evaporated to dryness, the scales so produced resemble albumen, and are not all soluble in water, but very soluble on the addition of a little alkali. Several other instances of the solubility of substances when endosmosed or dialysed are well known. The fluid thus naturally obtained is miscible with water, but coagulated by alcohol and by mineral acids. It cannot be obtained in sufficient quantity for exhaustive analysis, but it contains calcium, magnesium, and sodium, in small quantity, in combination with algin. If the laminaria fronds are cut up and macerated in dilute hydrochloric acid, the liquid in the vesicles assumes the form of a colourless, insoluble jelly. If the laminaria fronds are immersed in water containing a little alkali—by preference sodium carbonate—the whole plant becomes disintegrated, and presents a gelatinous mass, consisting of a thick, glutinous, gummy liquid, containing the cellular fabric of the plant completely broken up. This occurs in 24 hours in the cold. The mass, although it only contains 2 per cent of the algin, is so glutinous that it cannot be poured out of the bottle. It is very difficult to deal with, on account of its extraordinary thickness. In fact, as it is, no method of filtration is possible (all known methods, with and with-

out pressure, have been tried). The cells to be removed are so minute that, if pressure be applied, the whole mass passes through any filter or not at all. By cautiously heating the mass, it can, however, be filtered. The medium employed is a coarse linen sacking in the form of a Taylor's filter. The cellulose is left behind as a gelatinous mass, amounting, when dry, to about 10 per cent. of the air-dried plant.

The algin solution is then evaporated in a somewhat similar manner to gelatin, and, when dry, presents an appearance which is not unlike gum tragacanth; but it may also be obtained in thin transparent flexible sheets. The solution is slightly alkaline; but care must be taken that no great excess of sodium carbonate is present, or the solution decomposes, and in a week, if dilute, becomes quite thin, and contains no algin. This action of the alkali I cannot yet clearly explain. The solution can be neutralised by the careful addition of hydrochloric acid without gelatinising; but an excess at once precipitates it. A solution of only 2 per cent becomes semi-solid, treated in this way. The following reactions are obtained with various reagents. For some of these the solution must be carefully neutralised with acetic acid, which does not gelatinise it.

Dilute hydrochloric, nitric, sulphuric, sulphurous, phosphoric, and mineral acids generally, coagulate it. Boracic acid has no effect.

Lime water, baryta water, and salts of calcium, barium, and strontium give white precipitates.

Salts of magnesium do not affect it. Acetic, formic, citric, tartaric, and benzoic acids do not affect it.

It is precipitated by alcohol.

Perchloride of iron gives a dark brown coagulum.

Salts of copper, zinc, aluminium, tin, antimony, cobalt, and nickel all precipitate it.

Protonitrate of mercury forms a white precipitate, but bichloride of mercury and silver nitrate have no effect.

Acetate and subacetate of lead both give white precipitates.

Potassium silicate and bichromate, sodium biborate, and potassium ferro-cyanide, permanganate, sodium tungstate, stannate, and succinate do not affect it. No precipitate is produced by tannin.

Concentrated sulphuric acid dissolves it; concentrated nitric acid converts it into oxidation products, amongst which are oxalic acid, of which a specimen from this source is exhibited.

It is distinguished from albumen by not coagulating on heating, and by not precipitating silver nitrate—from gelose by not gelatinising on cooling, and by containing nitrogen, which gelose does not; and being soluble in cold, weak, alkaline solutions, which gelose is not; and being insoluble in boiling water, in which gelose is soluble. The laminaria has been boiled in water for a month without effecting any solution, and for a week under 40 lbs. pressure with a similar result.

It is distinguished from gelatine by not giving any reaction with tannin—from starch by giving no reaction with iodine; from dextrine, gum-arabic, gum tragacanth, and pectin by its insolubility in dilute alcohol and in dilute mineral acids.

I notice as particularly remarkable that it should precipitate all the salts of the alkaline earths except those of magnesium, and most of the metals except silver and mercury, and with regard to the latter that it should precipitate the protonitrate but not the bichloride; and that it gives no precipitate with potassium silicate.

The gelatinous precipitate produced by a mineral acid represents the algin in its pure insoluble form. It dries up to a hard, horny substance. The specimen shown can scarcely be distinguished from horn. I have not yet succeeded in getting it pure and definite enough to be certain of its composition; but I am indebted to Professor Ferguson for a combustion of the soda compound. This had been carefully dialysed to avoid the presence of excess of alkali, and gave the following numbers:—

Carbon	35·65
Hydrogen ..	4·40
Nitrogen ..	3·03
Oxygen	37·23
Ash	19·69 = sodium carbonate.
	100·00

This gives the following composition for the algin. I have appended also that of gelatin, isinglass, gelose, and chitin. In nitrogen it is intermediate between gelose and gelatin, but it approaches nearer to chitin than any other substance. Fremy, however, denies the presence of nitrogen in this substance. It differs entirely from algin in being insoluble in alkalies.

	Algin.	Gelatin.	Isinglass.	Gelose.	Chitin.
Carbon	44·39	50·0	50·1	42·77	46·64
Hydrogen ..	5·47	6·5	6·6	5·77	6·60
Nitrogen	3·77	17·5	18·3	—	6 56
Oxygen	46·37	26·0	25·0	51·46	40·20
	100·00	100·0	100·0	100·00	100·00

(Sulphur, 0·12.)

The percentage of ash in the soda compound does not materially vary. The two following were made—one with sodium hydrate, and the other with sodium carbonate—and yielded almost the same amount of ash:—

Sodium hydrate—percentage of ash ..	31·51
Sodium carbonate do. ..	31·37
Mean	31·44

Although I believe the composition to be stated correctly, I cannot construct a formula from these figures; and all attempts to procure definite compounds for analysis have as yet been unsuccessful. The following salts have been prepared and investigated with this view:—Compounds with calcium, aluminium, barium, and lead—but the results have not been uniform enough to show that we have been examining definite compounds.

The sodium carbonate appears to be unaltered in the compound, but completely masked. The carbonic acid comes off only when acidified with an excess of hydrochloric acid, and heated.

The acid has also some decomposing effect, and produces a small quantity of a substance which precipitates Fehling's solution, but does not appear to be glucose.

A solution, 1000 grs. measure, containing 13·2 grs. of algin, was precipitated by standard sulphuric acid, and re-dissolved by standard sodium hydrate, six times in succession.

1st precipitation took of sulphuric acid (SO_3), grs.	5·430
2nd ,, ,, ,,	4·070
3rd ,, ,, ,,	3·086
4th ,, ,, ,,	1·975
5th ,, ,, ,,	0·617
6th ,, ,, ,,	0·617
1st resolution took of soda (Na_2O), grains	3·778
2nd ,, ,, ,, ...	2·871
3rd ,, ,, ,, ...	2·052
4th ,, ,, ,, ...	1·530
5th ,, ,, ,, ...	0·670
6th ,, ,, ,, ...	0·478

As the precipitate is not soluble in sodium sulphate, there appears to be some decomposition continually going on, and this has not yet been sufficiently investigated to enable me to ascertain the exact action of the hydrochloric acid.

The process proposed to deal with the sea-weed is first of all to wash out the salts by simple maceration in cold water. This is very easily done, the salts being almost entirely removed, even by two macerations. On account of the bulk of the material it is, however, advisable to

wash a number of vats exhaustively in turns, in the usual manner of lixiviation common in alkali works. The water removes about a third of the weight of the sea-weed, and when evaporated to dryness presents a treacly mass containing the salts and a considerable quantity of a saccharine matter which resembles mamite, but which precipitates Fehling's solution equal to 15 per cent of glucose. It is, however, unfermentable, and I have not yet succeeded in getting it pure enough for analysis, on account of the great difficulty of separating it from the alkaline chlorides which are soluble in alcohol. By the use of sulphate of silver I have separated a small quantity, but still not sufficiently pure. If this can be separated commercially, and is a sugar having sweetness but unfermentable, it would be available for replacing glycerine in some of its applications. Until, however, more is known of its properties it must be sacrificed by carbonising the salts, the charcoal, of which it yields about 50 per cent, being then treated in the usual manner for separating the iodine and salts. The salts vary from 35 to 55 per cent of the whole; or 12 to 18 per cent. of the original air-dry weed in the laminaria. This is more than is obtained by burning the weed into ash, which does not, as a rule, yield more than 10 per cent of salts on the air-dried weed.

(To be continued.)

NOTICES OF BOOKS.

The Explosives Act 1875, *and the Orders in Council of April 20th*, 1883, *their Prejudicial Effect on Mining and Quarrying, and the Encouragement they give to Fenians.* London: A. P. Blundell and Co. 1883.

THE pamphlet before us is anonymous, and yet we think we could supply the author's name. He criticises the "Nitro-glycerine Act" of 1869, the "Explosives Act" of 1875, and the Act of the present season as calculated to do more harm than good. But we do not see what regulations he proposes to substitute, and we even suspect that he would wish the trade to be thrown open. He speaks of the "annoyance and loss" which recent legislation will occasion to persons requiring explosives for legitimate purposes. But he apparently forgets that these legitimate purposes are exceedingly few, being confined to quarrying, mining, and blasting in engineering operations. We believe that, by a foolish trade custom, miners and quarrymen have been in the habit of buying their own blasting-agents, and keeping the same in their dwellings, or in huts near the works. This custom should be abolished: the explosives should in future be bought and stored by the employer only, who would be held responsible for their safe-keeping, and served out to the workmen only when and as required. This simple change would do away with no small part of the author's contention. It must further be remarked that, in coal-mining at least, the use of explosives is being reduced, in consequence of the introduction of the lime-cartridge.

The author thinks it inconsistent that the recent regulations should not extend to gunpowder, which "may be used with powerful effect for malicious purposes." True, but nitro-glycerine, being much stronger than gunpowder, may be more easily secreted and carried about without attracting attention. He thinks that evil-disposed persons, "not being able to obtain such explosives in any other way, have been obliged to manufacture them themselves." Precisely, and this is a great gain to the community. The public enemy is thus put to much greater trouble and expense, and the chances of detection are indefinitely increased. Even in regular manufactories of the nitriles, with all the advantages of experienced workmen and well-arranged plant, accidents are not rare. Much more likely are such catastrophes to happen when amateurs are working in a stable, a kitchen, or a shed, and any such accident must at once lead to detection. Even the smell, and much more the colour, of nitrous fumes escaping should at once arouse the vigilance not merely of the police, but of the neighbours. We have often thought it exceedingly inconsistent that stringent regulations should be enforced concerning the sale of poisons, whilst the trade in explosives should be practically free. Yet explosives, in bad hands, are capable of effecting far more widespread damage than any poisons, whilst the legitimate uses of many of the latter are far more numerous and varied than those of dynamite, or even gunpowder.

Proceedings of the American Pharmaceutical Association at the Thirtieth Annual Meeting, September, 1882. Philadelphia: Sherman and Co.

THE first thing which strikes us in this volume is the second of the "Queries to be answered at the Thirty-first Annual Meeting, to be held at Washington during the coming summer." It runs:—"It has been said that if snow, formed in any month but April, be melted and bottled, the water will become ropy; but that snow which falls during the month of April, on the contrary, will furnish water which will remain limpid the summer through, and which can be used by pharmacists and photographers. Experiments on this subject are desired." This remarkable question has been undertaken by Mr. G. W. Sloan, of Indianapolis, and we shall look forward not without curiosity to his report.

Under the heading "Report on the Progress of Pharmacy" we observe a very extensive selection of valuable matter, some of which, however, such as a "safety-paper for cheques" and a black varnish for leather, have no very obvious connection with pharmacy.

Considerable space is devoted to the Pharmacy Acts of various States of the American Union. Some of these laws must, we should think, be found very inconvenient for the multitudes of persons who require poisons for scientific and technical purposes. The trade in such articles as the mineral acids, oxalic acid, ammonia, zinc and copper sulphates, lead acetate, &c., seems to be restricted to pharmaceutical chemists, with the necessary consequences. The seller is "not to deliver any of the said poisons to any person without satisfying himself that such poison is to be used for legitimate purposes,"—a very indefinite, and at the same time very difficult, stipulation. The penalties are in some cases heavy. We do not find in these Acts any mention of the soluble salts of barium, or of the soluble chromates, compounds quite as deadly as many of the substances included in the schedule. Nor is the common sale of explosives deemed a matter which requires legislative regulation.

CORRESPONDENCE.

THE AMMONIO-PHOSPHATIC DEPOSIT IN THE VICINITY OF CAPE TOWN.

To the Editor of the Chemical News.

SIR,—If Mr. Griffiths has made a full analysis of the above substance, I am sure the publication of it would interest many chemists.—I am, &c.,

HUANO.

Examination of a Double Sulphate of Iridium and Potassium.—Lecoq de Boisbaudran.—An examination of the green insoluble matter obtained on dissolving in water charged with neutral potassium sulphate the product formed on treating iridium compounds with potassium bisulphate at dull redness. This compound, though insoluble in saturated solution of potassium sulphate, is soluble in pure water.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 20, May 14, 1883.

Pyro-electricity of Quartz.—C. Friedel and J. Curie.—The authors have obtained, by heating, tensions of the same sign as those which M. Hankel has observed on refrigeration. In common with M. Röntgen, they conclude that the modes of development of electricity, distinguished by M. Hankel as *thermo-*, *actino-*, and *piezo-electricity*, are due to the same cause. According to M. Röntgen this cause is a change in the internal tensions of the crystal. The authors regard it as a change in the molecular distances.

Cultivation of the Cacao Tree: Researches on the Constitution of Cacao-beans and of Chocolate.—M. Boussingault.—The author gives as the result of a qualitative examination of cacao from Trinidad: Fatty matter, starch, theobromine, asparagine, albumen, gum yielding mucic acid, tartaric acid (free and combined), soluble cellulose, ash, and matters not determined. The composition of a genuine chocolate, which he used on his journeys in South America, is—

Sugar	20
Fatty matter	41
Albumen	10
Phosphate	3
Other matters	26
	100

Possibility of extending to any Surfaces whatsoever the Electro-chemical Method of Figuration of Potential Distributions.—A. Guebhard.—This memoir does not admit of useful abstraction.

Determination of Carbon Disulphide in the Sulphocarbonates.—A. Müntz.—This paper cannot be intelligibly reproduced without the accompanying figure.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 2, 1883.

Application of the Various Methods for the Determination of Vapour Densities.—V. Meyer.—From the *Berichte Deutsh. Chem. Gesell.*, xv., p. 2775.

Influence of Gum Arabic upon certain Reactions.—Jules Lefort and P. Thibault.—From the CHEMICAL NEWS.

A Pressure-Regulator for Determinations of Boiling-Points.—W. Städel.—A modification of the apparatus described in the *Zeitschrift*, vol. xviii., p. 574.

Apparatus for Registering the Disengagement or Absorption of Gases.—P. Regnard.—From the *Comptes Rendus*, xcv., p. 77.

Apparatus for Reducing Measured Volumes of Gases to the Normal Condition without taking the Temperature and Barometric Pressure.—Jos. Barnes.—From the *Journal of the Chemical Society*.

Preparation of Oxygen at Common Temperatures.—A. Guyard.—From the *Moniteur Scientifique* (3, 12, p. 781).

Electrolytic Behaviour of Thallium, Indium, Vanadium, Palladium, Molybdenum, Selenium, and Tellurium.—L. Schucht.—Already inserted.

Separation of Iron from Nickel and Cobalt.—T. Moore.—From the CHEMICAL NEWS.

The Solubility of Mixtures of the Salts of the Alkalies and Alkaline Earths at Different Temperatures.—H. Precht and B. Wittjen.—The authors give their results in tables, which may be found in the *Berichte* (xiv., p. 1667).

Determination of Chrome as Chromium Phosphate.—A. Carnot.—From the *Bulletin de la Soc. Chim. de Paris*, 37, p. 482.

Volumetric Determination of Chromium and Manganese in Presence of Ferric Oxide and Alumina.—E. Donath.—From the *Berichte*, xiv., p. 982. Already inserted.

Behaviour of the Salts of Gallium.—Lecoq de Boisbaudran.—From the *Comptes Rendus*.

Specific Gravity of Mercury.—P. Volkmann.—At 0° the sp. gr. of mercury is 13·5953.

Detection of Traces of Platinum.—F. Field.—From the CHEMICAL NEWS.

Quantitative Determination of Antimony.—A. Weller.—From *Liebig's Annalen*.

Volumetric Method for the Determination of Boric Acid.—E. F. Smith.—From the *American Chemical Journal*, iv., p. 279.

Specific Gravity of Hydrobromic Acid at Different Strengths.—J. Biel.—From the *Pharmaceutical Journal*.

Behaviour of certain Organic Compounds with Magenta-Sulphurous Acid.—J. Schmidt.—This paper will, if possible, be given in full.

Solubility of Different Modifications of Tartaric Acid.—E. Leidie.—From the *Comptes Rendus*.

Determination of Total Tartaric Acid in Crude Tartar.—MM. Goldberg and Geromont.—This paper will be inserted in full.

Determination of Glycerin in Fats.—J. David.—From the *Comptes Rendus*.

Detection of Salicylic Acid in Milk.—Ch. Girard.—100 c.c. water at 60° and 100 c.c. of the sample of milk are mixed with eight drops acetic acid and eight drops mercurous nitrate, shaken up and filtered. The filtrate is shaken up with 50 c.c. ether, which takes up the salicylic acid. After the evaporation of the ethereal solution the usual reagents can be applied to the residue.

Microscopic Examination of Flour.—The microscopic researches of L. Wittmack and A. Tomaschek are merely mentioned.

Determination of Starch-Syrup in Brown Sugar-Syrup.—P. Casamajor.—From the CHEMICAL NEWS.

Determination of Wool, Silk, and Cotton in Tissues.—A. Rémont.—This paper will be inserted in full.

Determination of Phosphorus in Iron.—E. Agthe.—(See page 253.)

Examination of the Ethereal Oils.—This memoir is not susceptible of useful abstraction.

Distinction of Olive Oil from Cotton-seed Oil.—Mr. Conray.—From the *Pharmaceutical Journal*.

Valuation of Potassium Sulpho-carbonates.—G. Dannecy.—From the *Journal de Pharmacie*.

Recognition of Genuine Beech-Tar Creosote.—H. Hager.—This paper will be inserted in full.

Determination of the Alkaloids of Cinchona Barks.—H. Meyer.—The author has studied the various methods of Prollius, Maens, De Vrij, Stœder, Eykmann, Hager, and Gunning.

Detection of Mercury in Animal Matter.—H. Paschkis.—The author defends the process of E. Ludwig against the objections of V. Lehman.

Detection and Determination of Aceton in Urine.—R. von Jaksch.—This paper does not admit of useful abstraction.

Determination of Urea with Sodium Hypobromite.—J. R. Duggan.—From the *American Chemical Journal.*

Determination of Glycogen.—E. Kulz.—The ordinary process assumes that this body can be completely thrown down from its aqueous solution by absolute alcohol. As this is not the case in the absence of mineral matter the author proposes to add a trace of sodium chloride.

New Urinary Pigments.—Two colouring-matters are here mentioned, which require further examination.

Behaviour of Urine with Diazo-benzol.—P. Ehrlich.—In certain pathological urines the diazo-compounds produce characteristic reactions.

Re-calculation of the Atomic Weights.—F. W. Clarke.—An abstract of Part V. of the "Constants of Nature."

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 4.

Solid and Gaseous Constituents of Sea-water, and on Oceanic Deposits. — Hercules Tonræ and L. Schmelck.—The questions raised were: Are differences in the respective proportions of the constituents perceptible in specimens of sea-water drawn at different places? If so, is any regularity to be traced in such differences? The oceanic region examined extended from 69° to 80° North Lat., and from 12° W. to 37° E. Long. from Greenwich. Lime, magnesia, sulphuric acid, and chlorine were determined in all the samples; potassa only in some few instances. Sodium was not determined, as a change in the proportion of sodium chloride would have been detected by the sp. gr. The specimens of water drawn at different depths and at remote points, evinced but very slight differences in composition. Certain deviations in the sp. gr. and in the total solids were due to a dilution of the sea-water, owing to the continued introduction of ice, or of fresh water, but the respective proportions of the various salts remained normal. The results support the generally accepted view of the approximately identical composition of the ocean throughout its extent. The percentage of organic matter is very small: 0·0025 grm. in 100 c.c. Hydrogen sulphide was never detected. If sea-water is boiled for some hours, constantly replacing the loss by evaporation, there is formed a precipitate of magnesium oxide perfectly free from lime, and the total carbonic acid is expelled. But, if sea-water is concentrated to half its original volume, only about half of the carbonic acid escapes, the precipitate consists of calcium carbonate and sulphate. On further concentration, calcium sulphate and sodium chloride are deposited, but even when the bulk of the latter is thus eliminated the mother-liquor contains all the potassium and magnesium salts. In determining the gaseous constituents of sea-water, the authors, like Buchanan, found the proportion of oxygen increased on approaching the pole. The oxygen decreases on descending, at first rapidly, and then more slowly, reaching its minimum at 1000 metres; it then slowly re-increases. The strata richest in saline matter are poorest in nitrogen. The remarks on the deposits at the bottom of the ocean belong rather to geology than to chemistry.

The Lupitz System of Farming and its Scientific Foundations.—MM. Schultz, Drechsler, Blomeyer, and Märcker.—The system depends on utilising the "source of nitrogen available in the atmosphere." As evidence of the value of this source he mentions a field of lupins, which received annually per acre 3 cwts. kainite, and yielded for fifteen years in succession not less than 6 cwts. seed and 12 cwts. straw per acre. A dose of 20 lbs. soluble phosphoric acid per hectare, four times repeated, was without effect. The author contends that the plants which collect nitrogen leave more of this ingredient in the soil if reaped when ripe than when green. Here he agrees with Voelcker, Pierre, and Déhérain, who have observed in ripening plants a recession of nitrogen and phosphoric acid from the tops of the plant to the roots. The chief collectors of nitrogen, besides lupins, are clover, tares, peas, and lentils. None of the authors admit the assimilation of free atmospheric nitrogen as possible. Prof. Märcker suggests that the store of nitrogen in the soil and the quantity derived yearly from the atmosphere may be greater than is commonly assumed. It is also suggested that carnallite may be found superior to kainite as a manure, from the circumstance that it contains its potassium, not as sulphate, but in the preferable form of chloride.

Researches on Sea-Mud.—Dr. M. Fleischer.—A chemical and physical analysis of the mud dredged up from harbours and estuaries on the coasts of Germany and Holland.

Action of Various Manures upon Potatoes.—Russell Swanwick and E. W. Prevost.—From the *Transactions of the Highland and Agricultural Society of Scotland.*

Occurrence of Myronic Acid and Determination of Mustard Oil in the Seeds of the Cruciferæ and in Oil-cake.—V. Dircks.—The author grinds up the seeds or the press-cake, introduces the powder into a retort, adds water, and connects the retort with a condenser and with one or two Will's absorption apparatus charged with an oxidising solution of 50 grammes permanganate and 120 grms. sodium hydroxide per litre. After the retort has stood for some time at a moderate temperature in the water-bath it is heated, and a current of air and one of hot steam are passed simultaneously through the apparatus. The liquid in the receivers is finally heated for some time, concentrated, mixed with strong hydrochloric acid, and evaporated to dryness; the residue is taken up with water and a few drops of hydrochloric acid, filtered, and, lastly, the sulphuric acid which has been formed is determined by precipitation with barium chloride. As the barium sulphate is contaminated with manganese it is fused with soda and saltpetre, the green melt evaporated to dryness, the manganese is separated by means of sodium acetate and bromine water, weighed, and deducted from the barium sulphate.

Justus Liebig's Annalen der Chemie, Band 217, Parts 2 and 3.

On the Nitration of the Phenol-ethers.—W. Staedel—In this very extensive memoir the author treats of the nitration of ortho-cresol-ethyl-ether, of the corresponding dinitro-compound, of dinitro-ortho-cresol; the nitration of meta and para-cresol-ethyl-ether, of the ethyl- and methyl-naphthol-ethers, the trinitro-naphthylamines, trinitro-naphthalines, and the nitration of the benzyl-ethers.

Nitro-phenols and Nitro-cresols.—W. Staedel.—We have here an account of dinitro-phenol-mono-nitro-benzyl-ether, of dinitro-ortho-cresol, mononitro-benzyl-ether, of the dinitro-ortho- and para-cresol-ethyl-ethers, of the preparation of symmetric-dinitro-toluol, the oxidation of sulpho-dinitro-toluol, yielding dinitro-benzoic acid, the reduction of sulpho-dinitro-toluol and para-nitro-benzyl-nitrate.

Amido-cresol-ethyl-ether.—W. Staedel.—The author gives his results in the form of a table.

Compounds of Benzo-trichloride with the Phenols and the Phenylamines.—Oscar Dœbner.—The compounds of benzo-trichloride with the phenols and phenyl-amines have the property in common with the previously known hydroxyl- and amido-derivatives of triphenyl-carbinol that they are all colouring-matters in the wider sense of the word, so that triphenyl-carbinol appears as the bearer of the colour-forming element. A further agreement in all is the transition under the influence of reducing agents, into the hydroxyl and amido-derivatives

of triphenyl-methan, which are colourless. Recent investigations have shown as derivatives of triphenyl-methan, the phthaleines, aurine and its homologue, rosolic acid, eupittonic acid, rosaniline and its derivatives. To them are joined the compounds of benzo-trichloride with the phenols and phenylamines, characterised by containing an intact phenyl group.

Communications from the University Laboratory of Halle.—These papers, all by E. Schmidt, treat of the action of hydrochloric acid upon caffeine, of theobromine, of the occurrence of caffeine in cacao, and the action of hydrochloric acid upon xanthine.

Contributions to a Knowledge of the Compounds of Gold.—P. Schottländer.—The author has studied the crystalline water of hydrochlorate of gold chloride, the action of silver carbonate upon the above-mentioned compound, certain reactions of potassium gold bromide, the action of manganese acetate upon neutral gold chloride, gold monoxide hydrate, gold trioxide hydrate, auryl-hydrate, the compounds of gold trioxide with nitric acid, and the sulphuric compounds of gold. In conclusion the author maintains that gold in the monoxide and its derivatives should be regarded as a bivalent element.

A New Product of the Slow Combustion of Ethyl-ether.—L. Legler.—Amongst the products of the slow combustion of ether, the author, in addition to formic and acetic acids, aldehyd, acetal, and methyl-aldehyd, has obtained a compound, $C_{11}H_{33}O_{21}$, with the examination of which he is still engaged.

Vol. 218, Part 1.

The Foundations of Thermo-Chemistry.—Lothar Meyer.—This paper will be inserted in full.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a paper by Dr. A. Geuther, assisted by Dr. H. Laatsch and Dr. A. Bauchmann, on the magnitudes of the affinities of carbon, and a memoir by Dr. W. Poetsch on the action of carbon monoxide upon a mixture of sodium acetate and sodium iso-amylate.

The Phenyl-Esters of Phosphorous Acid.—Dr. E. Noack.—The author has obtained a series of compounds derived from a symmetrical phosphorous acid $P(OH)_3$ not yet known in the free state.

The Density and the Chemical Affinity of the Elements in Various Allotropic Conditions.—W. Müller-Erzbach.—The author's researches extend to sulphur, selenium, phosphorus, carbon, silicon, boron, arsenic, and tin. Amongst these eight elements, which as solid bodies possess in different varieties different densities and affinities, it is questionable only in case of sulphur and silicon whether a higher degree of chemical affinity is not connected with a smaller specific gravity. In all other cases this connection is distinctly manifest, and in no case has there been a greater affinity observed along with a higher specific gravity. The behaviour of the so-called allotropic modifications of these elements furnishes new proof for the proposition that the activity of the chemical process is directly dependent on the possible lowering of the gravity of the reacting masses.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., March, 1883.

This issue contains no chemical matter.

Cosmos Les Mondes.
Tome v., No. 1, May 5, 1883.

Liquefaction of Oxygen and Nitrogen. Solidification of Carbon Disulphide and Alcohol.—MM. Wroblewski and Olszewski.—Already noticed.

MISCELLANEOUS.

Hoffmann and Power's "Manual of Chemical Analysis."—In our review of this work (Chemical News, xlvii., p. 235) we omitted to mention that Messrs. J. and A. Churchill, 11, New Burlington Street, London, are the publishers of the work in this country.

Lea Conservancy Board.—The appointment of Consulting Chemist to the Lea Conservancy Board, vacant since the death of Mr. T. W. Keates, has been offered to and accepted by Mr. W. C. Young, F.I.C., F.C.S., Public Analyst for the Districts of Poplar and Whitechapel.

Use of Dehydrated Oxalic Acid for Preparing Normal Acidimetric Liquids and Standard Permanganic Solutions.—Professor W. Hampe prepares this compound as follows:—Crystalline oxalic acid is dried at 100°, stirring carefully. It is then thrown by small portions into a platinum capsule heated on the sand-bath. Immediately above this capsule is fixed a precipitating vessel of Bohemian glass, perforated, and fitted with a paper bottom on the side turned towards the capsule; the paper is pierced with small pin-holes, so that a slow current of hot air passes through this diaphragm and the slit in the glass. There are soon formed long silky needles of sublimed oxalic acid which are collected by means of a feather, and kept under a bell-glass over sulphuric acid. For use, about 1 grm. of these crystals is weighed out in a stoppered tube and dried at 100°. If the acid has been kept for a sufficient length of time under the exsiccator its weight does not vary. Otherwise a few hours' exposure in a drying stove suffices to expel the traces of moisture absorbed. In all cases oxalic acid when once dry may be kept for hours at 100° without the slightest loss of weight.—*Monit. Scient.*

MEETINGS FOR THE WEEK

Monday, 4th.—Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry, 8. "The Packing of Goods of Delicate Odour, such as Tea, &c.," by G. W. Wigner, F.C.S. "On the Salt Deposits of the Cleveland District," by G. Ward, F.C.S.
Tuesday, 5th.—Royal Institution, 3. "Physiological Discovery," by Prof. McKendrick.
Wednesday, 6th.—Geological, 8.
Thursday, 7th.—Royal Institution, 3. "Recent Discoveries in Cyprus and Asia Minor," by Mr. R. S. Poole.
—— Royal, 4.30.
—— Chemical, 8. Ballot for the election of Fellows. "Laboratory Notes," by Dr. J. H. Gladstone and Alfred Tribe. "On Evaporation in vacuo," by Prof. H McLeod. "On a Basic Ammonio-Copper Sulphate," by Mr. Spencer U. Pickering.
Friday, 8th.—Royal Institution, 8. "The Electric Arc and Chemical Synthesis," by Prof. Dewar.
—— Astronomical, 8.
—— Quekett Club, 8.
Saturday, 9th.—Royal Institution, 3. "Russian Social Life," by Prof. Turner.
—— Physical, 3. "Improved Construction of the Movable Ring Galvanometer Adopted for Measuring both Strength of Current and Difference of Potential," by Dr. E. Obach.

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THE CHEMICAL NEWS.

Vol. XLVII. No. 1228.

THE ROYAL SOCIETY.

THE BAKERIAN LECTURE.

ON RADIANT MATTER SPECTROSCOPY: A NEW METHOD OF SPECTRUM ANALYSIS.*

By WILLIAM CROOKES, F.R.S.

For several years I have been examining the phenomena presented by various substances when struck by the molecular discharge from the negative pole in a highly exhausted tube. I have ventured to call this discharge "radiant matter," and under its influence a large number of substances emit phosphorescent light, some faintly and others with great intensity. On examining the emitted light in the spectroscope most bodies give a faint continuous spectrum, with a more or less decided concentration in one part of the spectrum, the superficial colour of the phosphorescing substance being governed by this preponderating emission in one or other part of the spectrum. Sometimes, but more rarely, the spectrum of the phosphorescent light is discontinuous, and it is to bodies manifesting this phenomenon that my attention has been specially directed.

For a long time past I have been haunted by a bright citron-coloured band or line appearing in these phosphorescent spectra, sometimes as a sharp line, at others as a broader nebulous band, but having always a characteristic appearance and occurring uniformly in the same spot. The best way to bring out the band is to treat the substance under examination with strong sulphuric acid, drive off excess of acid by heat, and finally to raise the temperature to redness. The anhydrous sulphate thus left frequently shows the citron band in the radiant matter tube, when before this treatment the original substance shows nothing. I soon came to the conclusion that the substance I was in search of was an earth, but on attempting to determine its chemical properties I was baffled.

Much chemical evidence tended to support the view that the band might be due to a compound of lime. By neglecting the portion showing least citron band, and separating all the elements present which gave little or none, I could generally concentrate the citron band into a solution which—according to our present knowledge of analytical chemistry—should contain little else than the earths, alkaline earths, and alkalies. Ammonia added to this solution would precipitate an earth, and in the filtrate oxalic acid would precipitate an insoluble oxalate, showing the citron band strongly. This was found on analysis to consist of strontic and calcic oxalates. The strontia being separated, the remaining lime formed an oxalate which gave the citron band.

So far all the chemical evidence went to show that the band-forming substance was calcium, and further tests tried with the purified oxalate confirmed this inference. Every analytical test to which it was subjected showed lime, and nothing but lime; all the salts which were prepared from it resembled those of lime, both physically and chemically; the flame spectrum gave the calcium lines with extraordinary purity and brilliancy; and, finally, the atomic weight, taken with great care, came out almost the same as that for calcium, 39·9 as against Ca 40.

* Abstract of the Bakerian Lecture delivered before the Royal Society, May 31st, 1883.

On further examination it was found that most native compounds of lime gave the citron band. It was found in clear and colourless Iceland spar, native calcic phosphate, a crystal of arragonite, a stalactite of calcic carbonate from Gibraltar, cinnamon stone (lime alumina garnet), iron slag from a blast-furnace, pink coral, commercial plaster of Paris, and most specimens of ordinary burnt lime.

Evidence stronger than this in favour of the view that the citron band was an inherent characteristic of calcium could scarcely be; but, on the other hand, there was evidence equally conclusive that the band was not essential to calcium.

Starting with a lime compound which showed the citron band, I could always obtain a calcic oxalate which gave the band stronger than the original substance; but if I started with a lime compound which originally gave no citron band, I could never by any means, chemical or physical, constrain the lime or the earthy precipitate to yield a citron band.

The only explanation that I could see for this anomaly was that the elusive citron band was caused by some element precipitated with the calcic oxalate, but present in a quantity too small to be detected by ordinary chemical means. The calcic oxalate was ignited and dissolved in hydrochloric acid, and fractionally precipitated in three portions with ammonic oxalate, the first and third portions being comparatively small. They were then tested in the radiant matter tube. All three portions showed the citron band, but the portion which came down first gave the band decidedly the strongest, and the third portion precipitated showed it weakest.

It having been found that the substance giving the citron band formed a sulphate more soluble in water than calcic sulphate, four pounds weight of commercial plaster of Paris, which showed very faint traces of the citron band, were mixed with water and poured on a large filter. A few ounces of water were poured on, and after passing through, poured back, and the exhaustion repeated several times. The aqueous extract was then evaporated to dryness, ignited with sulphuric acid, ground in a mortar with small successive quantities of water, and precipitated with ammonic oxalate. The precipitate, ignited with sulphuric acid, showed the citron band very fairly, far more intensely than it was seen in the original calcic sulphate.

These experiments are conclusive in proving that the citron band is not due to calcium, but to some other element, probably one of the earthy metals, occurring in very minute quantities but widely distributed along with calcium, and I at once commenced experiments to find a more abundant supply of the body sought for. Amongst other substances tested I may note the following as giving a more or less decided citron band in the spectrum when treated with sulphuric acid in the manner indicated above:—Crystallised barytic chlorate, heavy spar, common limestone, strontic nitrate, native strontic carbonate, crystallised uranic nitrate, commercial magnesic sulphate, commercial potassic sulphate, tobacco ash, Wagnerite (magnesic phosphate and fluoride), zircon, cerite, and commercial ceric oxalate.

Some specimens of zircon appeared sufficiently rich to make it probable that here might be found an available source of the citron-band yielding body. I found it in crystals from Green River, North Carolina, from Ceylon, from Expailly, from Miask (Oural), and from Brevig, and having a good supply of North Carolina zircons, these were worked up by a process given in detail in the paper.

I may condense a year's work on zircon,—over ten lbs. weight of crystals from North Carolina having been worked up—by stating that the result was comprised in about 300 grains of an earthy residue, and about two ozs. of oxalate, chiefly calcic; the former gave the citron band very well.

The zirconia prepared from these zircons, when tested, sometimes showed the citron band, and at other times none. A zirconia rich in citron band, fractionally precipi-

tated by ammonia, yielded precipitates of increasing richness, the last fraction showing the citron band strongly.

The calcic oxalate obtained from zircon gave unsatisfactory results, so attention was directed to the earthy residue. This was found to be of highly complex character, containing thoria, ceria, lanthana, didymia, yttria, and probably some of the newly-discovered rarer earths.

The position of the citron band in the spectrum falls exactly on the strongest absorption band of didymium, so that a piece of didymium glass or cell of solution of the nitrate entirely obliterates the citron band. This naturally suggested that the band was due to didymium.

Cerite was accordingly the next mineral experimented on. The powdered mineral tested in the tube in the original way give a good citron band. The mixed earths after extraction were converted into sulphates, dissolved in water, and the cerium metals precipitated by long digestion with excess of potassic sulphate.

The precipitated double sulphates were converted into oxalates, and after ignition and treatment with sulphuric acid, the mixed ceria, lanthana, and didymia were tested in the radiant matter tube, but the merest trace only of citron band was visible.

This experiment proved the inadequacy of the didymium explanation, and further tests showed that not only could I get no citron band in pure didymium compounds, but the spectrum entirely failed to detect didymium in many solutions of the earth which gave the citron band brilliantly.

Attention was now turned to the solution filtered from the insoluble double sulphates. Potash was added, and the precipitate filtered off, and tested in a radiant matter tube. The spectrum, of extraordinary brilliancy, was far brighter than any I had hitherto obtained. Unfortunately, however, the quantity was too small to be subjected to very accurate chemical analysis.

Search was now made amongst other minerals rich in the rarer earths. Thorite was finely powdered, treated with sulphuric acid, and tested in the radiant matter tube. It gave the citron spectrum most brilliantly—equal in fact to the mixture of earths obtained from zircons at so great an expenditure of time and trouble. Orangite treated in the same manner gave almost as good a spectrum. Pure thorinic sulphate prepared by myself was found not to give the citron band, but three specimens prepared and given to me by friends all gave it, so it was not unlikely that in thorite and orangite might at last be found a good source of the long-sought element—that in fact the body I was hunting for, if not thorina, might possibly be Bahr's hypothetical Wasium. Two pounds of orangite and thorite were extracted with hydrochloric acid. The solution was precipitated with potassic sulphate, taking the usual precautions to secure complete precipitation. A bulky precipitate ensued, which contained the thorina and cerium earths. These were separated and tested, and found to give only a faint citron band.

The solution of earthy sulphates soluble in potassic sulphate was precipitated with ammonic oxalate. The precipitate ignited with sulphuric acid, and tested in a radiant matter tube, gave the citron spectrum with great brilliancy.

Certain chemical facts concerning the behaviour of the sought-for element which came out during the course of the tentative trials described in the paper considerably narrowed the list amongst which it might probably be found. All the evidence tends to show that it belongs to the group of earthy metals, consisting of aluminium, beryllium, thorium, zirconium, cerium, lanthanum, didymium, and the yttrium family, together with titanium, tantalum, and niobium. The sought-for earth is insoluble in excess of potash; this excludes aluminium and beryllium. It is not precipitated by continued boiling with sodic thiosulphate; this excludes aluminium, thorium, and zirconium. Fused with acid potassic sulphate, the resulting compound is readily soluble in cold water; this excludes tantalum and niobium. Evaporating to dryness with hydrochloric acid and heating for some time does not render the mass insoluble in water; this excludes titanium and silicium. It is easily soluble in an excess of a saturated solution of potassic sulphate; this excludes thorium, the cerium group, some of the numerous members of the yttrium group, and zirconium. The only remaining elements among which this elusive body would probably be found are those members of the yttrium family which are not precipitated by potassic sulphate.

The yttria earths form a somewhat numerous family. Fortunately for chemists, a mineral rich in yttria earths —samarskite—has been found lately in large quantity in Mitchell County, North Carolina, and to this mineral I accordingly now directed my attention.

The following list of elements of the yttrium and its allied families said to occur in samarskite and similar minerals may be considered complete to the present time.

Name.	Absorption Spectrum.	Hydrogen equivalent of Metal.* (Type of Oxide M_2O.)
Cerium	No	47·1
Decipium	Yes	57·0
Didymium	Yes	48·5
Didymium β	Yes	47·0
Erbium	Yes	55·3
Holmium	Yes	54·0
Lanthanum	No	46·0
Mosandrum	No	51·2
Samarium	Yes	50·0
Scandium	No	14·7
Terbium	No	49·5
Thulium	Yes	56·5
Ytterbium	No	57·9
Yttrium	No	29·7
Yttrium α	No	52·2
Yttrium β	Yes	49·7

Some of these claimants it is certain will not stand the test of further scrutiny. Thus samarium and yttrium β are in all probability identical; and I have not included philippium, as Roscoe has conclusively proved that this is a mixture of terbium and yttrium, and my own results confirm those of Roscoe. Moreover, some of these so-called elements will probably turn out to be mixtures of other known elements. But in the confessedly very imperfect state of our knowledge of the chemistry of these metals it is not safe for me in this research to assume that any one of them will surely not survive. The complete list as it stands will therefore be taken to contain all hitherto claimed as new, although it is almost certain to include too many.

In the second column "Yes" or "No" indicates whether the solutions give an absorption spectrum when examined by transmitted light. After numerous experiments I satisfied myself that the metal giving the citron band spectrum was not one of those giving an absorption spectrum. The possible elements, therefore, became narrowed to the following list:—Cerium, lanthanum, mosandrum, scandium, terbium, thorium, ytterbium, yttrium, yttrium α and zirconium.

Of these the potassic sulphate reaction excludes cerium, lanthanum, scandium, thorium, yttrium α, and zirconium, so there are left only the following:—

Mosandrum,
Terbium,
Ytterbium,
Yttrium.

Certain chemical reactions for a long time made me dismiss yttrium from the list of likely bodies. In my

* As it is at present doubtful whether the oxides of several of the metals in this Table belong to the type M_2O, M_2O_3, or MO, I have, for the sake of uniformity and simplicity in calculating the values from the composition of their salts, by which these metals are chiefly discriminated, taken the type of oxide to be M_2O.

analysis of zircons, towards the latter part of the process, I used the following process to separate the iron:—The solution mixed with tartaric acid and excess of ammonia was allowed to stand for some time. A small quantity of a precipitate gradually formed, which was filtered off, and it was this filtrate, after separating the iron with ammonic sulphide, that yielded the greatest quantity of substance giving the citron band. Now one of the methods of separating yttria from alumina, berylla, thoria, and zirconia is to precipitate it as tartrate in the presence of excess of ammonia, the other earths remaining in solution. Fresenius says:—"The precipitation ensues only after some time, but it is complete."

The precipitate thus obtained with tartaric acid and ammonia should therefore contain all the yttria: *it gave no citron band whatever in the radiant matter tube;* whilst the residue, which should be free from yttria, proved for a long time the only source of material wherewith to investigate the chemical properties of the body giving the citron spectrum.

Another reason which made me, at this stage of the research, pass over yttria, was that I had already tested this earth in the radiant matter tube. In a paper on "Discontinuous Phosphorescent Spectra in High Vacua," read before the Royal Society, May 19th, 1881, I said—"Yttria shows a dull greenish light giving a continuous spectrum."

For these reasons I for a long time omitted yttria from my list of possible bodies, and considered that the earth, if not a new one, might turn out to be either mosandra, terbia, or ytterbia.

About 15 lbs. weight of samarskite was worked up, partly by the hydrofluoric acid method of Lawrence Smith, and partly by fusion with potassic bisulphate.

These methods both gave as a result a large quantity of mixed earths containing most, if not all, the bodies enumerated in the foregoing list. Tested in the radiant matter tube this mixture gave the citron spectrum very brilliantly.

These earths were treated by a series of chemical processes too long and complicated to describe in this abstract, and the result of about five hundred fractional precipitations gave me a mixture of earths having an H equivalent, M = 48, and showing a strong absorption spectrum; a mixture having an H equivalent, M = 33, having no absorption spectrum; and intermediate earths.

In the radiant matter tube all these fractions gave the citron band spectrum well, but that of the earth of lowest equivalent was much the brightest, and that of the highest equivalent the least intense.

Three methods are available for the partial separation of these earths and for the complete purification of any one of them. The formic acid process is best for separating terbia, as terbic formate is difficultly soluble in water, the other formates being easily soluble.

Fractional precipitation with oxalic acid separates first erbia, holmia, and thulia, then terbia, and lastly yttria. This is the only method which is applicable for the separation of small quantities of terbia from yttria.

Fusing the nitrates separates ytterbia, erbia, holmia, and thulia from yttria. It is not so applicable when terbia is present, and is most useful in purifying the gadolinite earths. This process is the only one known for separating ytterbia from yttria.

Selection must be made of these methods according to the mixture of earths under treatment, changing the method as one earth or the other becomes concentrated on one side or thrown out on the other. Each operation must be repeated many times before even approximate purity is attained. The operations are more analogous to the separation of members of homologous series of hydrocarbons by fractional distillation than to the separations in mineral chemistry as ordinarily adopted in the laboratory.

Pure terbia ignited with sulphuric acid and tested in the radiant matter tube shows no citron band spectrum. A concentrated solution of the purest terbia obtained in this way, when examined by the spectroscope, showed no absorption lines whatever: proving the absence of erbium, holmium, and thulium.

I did not attempt any separation of erbium, holmium, and thulium from each other, as the evidence obtained was sufficient to show that the element giving the citron band spectrum was not one of these three metals. Likewise I had far too little material to enable me to enter on a work of such difficulty with any prospect of success.

The chemical characters of mosandra are so little known that I could not attempt to search for it. But as the citron band-forming earth always appeared concentrated amongst those whose double sulphates were most soluble in potassic sulphate,—and, of these, amongst those having the palest colour and lowest atomic weight,—it was scarcely conceivable that the earth I was in search of should ultimately prove to be one whose properties did not in any case correspond to these,—of a dark orange yellow colour, forming a difficultly soluble double potassic sulphate, and having the very high equivalent ot M = 51·2; these being the properties ascribed to mosandra by the discoverer, Professor Lawrence Smith.

Ytterbia was prepared from gadolinite, as this mineral is said by Nilson to contain most ytterbia. It was separated from accompanying earths by processes described in the paper. The resulting earth gave at first a faint citron band spectrum, evidently due to impurity; on repeating the purification several times I at last succeeded in obtaining a white earth which gave only the merest trace of citron band spectrum. Its hydrogen equivalent, 58·0, and its chemical properties showed that it was probably Marignac's ytterbia. Subsequent experiments satisfied me that this earth did not contain more than 1-10,000th part of yttria. The extreme tediousness of the chemical operations necessary to obtain this high degree of purity, and the long time they required, prevented me from pushing these results beyond what was necessary to prove the special point at issue.

The yttria, purified as already described, might still contain traces of terbia, together with erbia, holmia, and thulia. These were gradually removed by the fusing nitrate process. The atomic weight gradually got down to 31·0, but the spectra did not vary very much; that from the earth of lowest atomic weight being, however, the most brilliant.

Pure yttria is quite white. That from gadolinite on testing in the radiant matter tube gave a spectrum absolutely identical with that given by the zircon, cerite, thorite, orangite, and samarskite yttria. Pure yttria was also prepared from yttro-tantalite, euxenite, tyrite, and also from plaster of Paris and common limestone. In no case could I detect any difference in the position or intensity of the lines shown by their phosphorescent spectra.

The Phosphorescent Spectrum of Yttria.

The spectrum shown by pure ignited yttric sulphate in a radiant matter tube is one of the most beautiful objects in the whole range of spectroscopy. The spectrum is best seen under low dispersion and not too narrow a slit. It consists essentially of a broad red band, an intensely brilliant citron band, and two almost equally brilliant green bands. Other fainter lines are also seen, but they are not characteristic. Coloured drawings and maps of the spectrum to scale accompany the paper. This description applies to the spectrum shown either by pure yttric sulphate or by an earth tolerably rich in yttria. When traces are present the citron band only is seen. A little more yttria brings out the first and then the second green band, and finally, as the proportion of yttria increases, the red and blue bands appear.

The paper next gives a description of experiments made with pure yttria, and with various compounds of it, to see which would give the most characteristic spectrum. The sulphate heated to redness was found to give the best re-

sults. Pure yttria precipitated by ammonia did not phosphoresce in the slightest degree, and, necessarily, no citron band spectrum was to be seen. The yttria was removed from the tube, converted into sulphate, heated to redness, and again tested. This time it gave the citron band magnificently. This shows what apparently trivial circumstances will alter the whole course of an investigation. In 1881, when searching for discontinuous phosphorescent spectra, I tried a similar experiment with pure precipitated yttria, and entirely missed its citron band spectrum. Had I first treated the yttria with sulphuric acid instead of testing the earth itself in the radiant matter tube the results would have been very different, and this research would probably have never been undertaken.

Yttria was now prepared by igniting the precipitated oxalate at a red heat. On testing it in the radiant matter tube it phosphoresced with feeble intensity, the light being about one-twentieth of that given by the ignited sulphate under similar conditions. The citron band was almost as sharp as the sodium line, and was shifted one division towards the blue end. The two green bands were visible, but very hazy and indistinct, and only to be resolved into bands with difficulty.

It is an old and probably a true saying that every element could be detected everywhere had we sufficiently delicate tests for it. Early observations had prepared me for the wide distribution of yttrium, and no sooner had the exquisite sensitiveness of this spectrum test forced itself on my notice than I sought for yttrium in other minerals. The facts which I had noticed in connection with the variation of the appearence of the citron spectrum, according to the quantity of yttrium present, showed that it might be possible to devise a process for the rough quantitative estimation of yttrium, and after several experiments a spectrum test was devised sufficiently delicate to detect one-millionth part of yttria in a mineral. A table is given showing the results of this quantitative spectrum analysis, from which it is seen that amongst other substances pink coral contains one part of yttrium in 200 parts; strontianite, one part of yttrium in 500 parts; chondrodite, from Mount Somma, one part in 4,000; calcite, one part in 10,000; ox bone, one part in 10,000; an earthy meteorite (Alfianello), one part in 100,000; and tobacco ash, one part in 1,000,000.

THE FOUNDATIONS OF THERMO-CHEMISTRY.

By LOTHAR MEYER.

THE author shows at some length that notwithstanding the great number of thermo-chemical determinations, and the trustworthiness of a not inconsiderable portion of the constants thence deduced, little can be perceived of a homogeneous, coherent theory of chemical transformations based upon a thermo-chemical foundation. Attempts in this direction have met with doubt, if not with opposition. Though entire series of observations seem to be subordinate to the universally recognised principles of the thermic theory, others appear, often in great numbers, so contradictory that they cannot be brought into harmony even by the acutest interpretation.

The cause of this disagreement is to be sought in an improper application of the doctrines of the mechanical heat theory. Here, in fact, according to my apprehension, lies the entire cause of the present uncertain and unsatisfactory condition of the chemical theory of heat. We torment ourselves with worn-out hypotheses and theoretical conceptions which have long ago been thrown aside by the physicists, and we wonder that phenomena do not take place as we predicted in accordance with these dogmas.

The first, but not the most dangerous, of such dogmas is the assumption that the atoms are particles of masses endowed with attraction acting through space. Yet it is very possible, even if not highly probable, that everything which we call attraction is produced by certain movements of small molecules, by impact or pressure. If this holds good also concerning affinity, its satisfaction consists not in a transformation of potential into kinetic energy, but both combination and decomposition are simply conversions of one form of kinetic energy into another. The difference in the manner of interpreting phenomena is not very great, but it throws a doubt on the far-reaching conclusions which have been drawn from the proposition that decomposition necessarily involves the production of potential energy, whilst combination is a transfer of potential energy into kinetic.

But even if we retain the accepted, though unproved, hypothesis on the nature of affinity, we find in the views which are explicitly or tacitly used as the foundation of thermo-chemical speculations, many an untenable conception, and many a dogma based thereon. Without their removal thermo-chemistry will never arrive at clearness.

Though no one will now seriously maintain that the chemical atoms are particles of matter *at rest*, yet the thermo-chemical doctrines which have been latterly most strongly emphasized, proceed from this assumption, and stand thus on a foundation which their authors do not admit as correct. This applies especially to the proposition which has been more or less distinctly announced in different forms, that in the absence of disturbing collateral action, chemical transformation always takes place according to those affinities which in their saturation produce the greatest heat.

If we conceive the atoms as *particles of matter at rest*, whose mutual attractions (affinities) decrease with increasing distance, according to any law, but certainly very rapidly, then two atoms, A and B, on being so nearly approximated to each other that the attractions come into play, will move towards each other, and on contact their potential energy will be entirely transformed into kinetic energy, which may partially or entirely assume the form of heat. If a third atom, C, comes near, whose affinity for A exceeds that of B, still no transformation takes place so long as the attraction between A and C, on account of the greater distance, is smaller than that between A and B. Not until it has been brought by any cause sufficiently near will it combine with A and drive out B. The kinetic energy (heat) thus arising is equivalent to the potential energy which existed between A and C, less the amount of work expended in separating A and B. Any decomposition of the compound A C by B is completely excluded, and therewith any chemical transformation involving the consumption of heat.

But the conception upon which this view is based does not in the least correspond to the real behaviour of the chemical elements and of their compounds. The atoms and molecules are particles of matter not at rest, but in very brisk movement. Each molecule is not merely in motion as a whole, but its individual parts—the atoms of which it is composed—have also especial movements, which are, however, limited so far that none of them can remove to any distance from the other atoms of the molecule.

The form and the strength of these movements depend, in addition to the nature of the matter, primarily upon the temperature, and very often upon the space which is offered to a given quantity of matter. Concerning the form of the molecular movements, especially of gases, we can make some moderately certain assertions. What forms the atomic movements the atoms have within the molecule is substantially quite unknown. But we may maintain that they are either of such a nature that their *vis viva* remains always equal, or that it alternately decreases and increases at the expense of so-called tension or potential energy. The first case would, *e.g.*, occur if an atom revolved on itself, or if several atoms described circular tracks round each other, or round some common

centre of gravity. The second case would occur if the orbits were elliptical, or if the atoms moved to and fro. Movements of this second kind are the most probable by which the mutually attracting atoms alternately approach and recede from each other. If the movements of the atoms in the molecule are of this kind its decomposability will be sometimes smaller, sometimes greater, according to the relative positions which the atoms occupy at the moment. It is therefore quite possible that one and the same substance may be decomposed in one case, and not in another, by the action of one and the same substance, without our being able to distinguish a difference in the external conditions, especially in the temperature.

For the decomposition of a compound A B, by an atom C, it is not even necessary that in any position the attraction between A and B should be smaller than that between A and C. On the contact of the violently moving particles the most various results may ensue. One possible case is that whilst A and B are at their greatest distance from each other, C impinges upon A with great velocity, driving it quite out of the sphere of action of B, and combining with it. A part of the *vis viva* of C is thus consumed in overcoming the affinity of A for B, whilst again heat, or some other form of kinetic energy, is produced from the affinity of A for C. Whether after the transformation the kinetic energy of the whole system formed of these atoms is greater or less than before, depends on whether C or B has the greater affinity for A. But for the occurrence of the transformation it is evidently not necessary that B should have the greater (less ?), since C may make up in *vis viva* what is wanting in affinity. The temperature after the change will be lower, but this does not render the process impossible.

Of course just as A B is decomposed by C, inversely A B may be re-constituted from A C and B. We might even be tempted to believe that by reason of the greater affinity this re-constitution must be easier, and must therefore occur more frequently than the decomposition, so that each quantity of the compound A C formed would be again decomposed, and finally the transformation involving the greatest action of heat would gain the upper-hand. This assumption is by no means necessary, as the possibility and the ease of a chemical union depend not merely on the strength of the affinities, but also on other properties of the atoms and compounds, and on external circumstances. For combination it is not enough that the particles should come in contact, but it may essentially depend upon the kind of the contact. If, *e.g.*, C can combine with A in every position, but B only when A approaches it from a certain side, as will be the rule with compound radicles, A C will be more readily formed than A B, and every A which becomes isolated on collision will soon find a B with which it combines, whilst it may meet perhaps a hundred times with a B before the compound A B can be re-constituted.

Accordingly we see that many chemical transformations are accompanied by their exact opposites ; a heat-liberating and a heat-absorbing process may go on side by side under identical external conditions.

It is usual here, in order to save the dogma, to maintain that the one process is due to the action of affinity, and the inverse one to that of heat, consequently to an external cause. This is, however, little better than a play with words, since certainly very few chemical transformations—probably none at all—take place without heat. But if heat is concerned in both the above-mentioned processes, it is arbitrary to say that the one ensues by affinity, with the aid of heat, and the other by heat, aided by a feebler affinity. If we call the heat which the mutually reacting bodies possess as molecular or atomic motion, a foreign energy, there is perhaps no chemical change which is effected without the aid of such foreign energy ; certainly it could only be observed at the absolute zero, $-273°$.

The difference between the chemical transformations taking place with liberation and with absorption of heat is not principial. As far as the chemical changes of matter are accessible to our observation, they take place under the influence of light, of heat, of electricity, and of other forms of kinetic energy. Scarcely anywhere is the union of two atoms dissolved without their own kinetic energy taking part in the work performed in overcoming their affinities. The loss thus arising is generally covered by the heat evolved from the newly-combining affinities, so that the final result is the same as if the entire work of dissolving the former combination had been effected by them alone. Nevertheless we are not at once entitled to place this work entirely to the account of what has been consumed ; the case is not rare when this would not be correct even for a part of the work. Supposing a compound A B decomposed by the action of a high degree of heat communicated to it ; let the atom A, thus liberated, meet with a third atom, C, and unite with it ; the heat-relation of the entire process is exactly the same as if the compound A B had been decomposed by the affinity of C for A. Yet in reality two processes have taken place, having no further connection than that the one furnishes the material for the other.

Neither theoretical considerations nor observations compel the assumption of a principial difference in the transformations accompanied by liberation and with absorption of heat. Such an assumption would, on the contrary, throw out of connection a number of closely-connected facts,—*e.g.*, the decompositions of salts and analogous compounds by acids or bases which are accompanied by a rise or a fall of temperature, not merely according to the nature of the substances, but according to the quantities which act upon each other.

Recent investigations on the action of masses have shown very plainly that many, if not most, chemical changes are accompanied by their exact opposites, so that there never occurs a state of rest without change, but a condition of equilibrium in which the transformation effects exactly as much in one direction as it destroys in the opposite. Hence an absorption of heat constantly compensates an equivalent liberation of heat. It cannot, therefore, be said that transformation takes place only in the direction of the heat-producing affinities. In very many cases the reaction attended with absorption of heat greatly predominates, so that an acid possessing a small neutralisation heat takes away the greater part of the base from another acid with a greater neutralisation heat, the process being attended with the production of cold.

Concerning a part of these changes, especially the neutralisation of acids and bases, we know—what probably holds good of many other transformations—that the accompanying thermic changes, as well as certain other physical processes, such as the changes in volume and in the refraction of light, depend *not on the mutual relations of the combining bodies*,—*i.e.*, on their respective affinities,—*but on the nature of each taken individually*. The changes in heat, in volume, in the refraction of light, consists always of two parts, the one depending only on the nature of the acid and the other on that of the base. The neutralisation of an acid with potassa always produces a certain number of calories more, and an expansion to a certain greater extent, than neutralisation with ammonia, whatever may be the nature of the acid. The neutralisation of a base with sulphuric acid always evolves a constant number of calories greater than appears on neutralisation with hydrochloric or nitric acid, whatever may be the base concerned. If therefore the neutralisation-heat of one base with all acids, and of one acid with all bases, is known, that of any conceivable combination of acids and bases may be easily calculated. The neutralisation-heat is just as little dependent on the strength of the neutralised afinities as are the equivalent weights ; it is merely the consequence of a change of condition brought about by affinity. The neutralisation-heat proper to the substance in question is set at liberty as soon as neutralisation takes place, by whatever it is produced. Affinity effects merely the liberation of the available energy, just

as a tiny spark or an entire firebrand causes a cask of powder to explode with equal strength.

What holds good for neutralisation applies probably also to many other reversible processes; whether it extends to such as are not reversible cannot yet be determined. Certain classes of these phenomena, such as the precipitation of the metals, including hydrogen, by each other, the replacement of one haloid by another, and many other transformations occur, commonly, though not always, with liberation of heat. Still, it remains doubtful whether the connection between the quantity of heat liberated and the strength of the affinities is so direct as is commonly assumed; whether, in other words, the heat evolved is a correct gauge of the strength of the affinities satisfied, and the heat absorbed a measurement of the strength of the affinities dissolved.

If the metals are arranged in a series so that each is precipitated from its solutions by the next following, we obtain, with few exceptions, the same classification as if they were arranged according to the thermic changes which accompany their solution. The series is also essentially identical with the series of electric tension which contains the metals arranged according to the electromotive powers which each two of them are able to produce with the proper solvent. But for this very electromotive power proof has been recently given that its alleged proportionality with the quantity of heat produced by the chemical change occurring in the current does not hold good, the electromotive power being sometimes smaller, sometimes greater, than it ought to be according to the erroneous doctrine of the equivalence of the electromotive power to the chemical transformation of the current. It has been shown that only a part of the energy liberated in this transformation and designated "free energy," is available for the production of the current or for other duties, whilst another portion, known as "combined energy," is not thus available. It may be foreseen that also as regards other results of the energy contained in the chemical elements and compounds, including pure chemical actions, a separation into these two parts will be needful before the laws of its transformations and of its relations to what we call affinity can become manifest to us. Nothing but the long road of laborious research, experimental and theoretical, will conduct us thither. On our way the masses of thermo-chemical observations already accumulated will doubtless arrive at very great importance for the clear insight into the nature of chemical processes. Present theoretical considerations, however, are not yet equal to the right utilisation of the accumulated materials, and they seek for the solution of the difficult problem in too simple a manner. It is possible, and even probable, that when once the true solution has been found, the hypothesis of affinity as an attractive force will disappear, and in its place will come an insight into the nature of matter of which we can as yet scarcely dream.—*Liebig's Annalen.*

A NOTE UPON THE WORKING OF SULPHURIC ACID CHAMBERS.*

By HENRY PEMBERTON, Jun.

DURING several years subsequent to the panic of 1873 a set of acid chambers, the property of a company of this city, was worked under my supervision. Owing to the depressed state of trade, and consequent stock of goods on hand, the chambers were often run below their full capacity. They were run without a Gay-Lussac absorbing tower, and burned best unmixed seconds brimstone, 4000 pounds being the normal charge in twenty-four hours. Good results, approaching very nearly to the theoretical figures, were obtained from such a charge when 10 p. ct. nitre was used. Burning 3600 pounds per day, 9 per cent nitre was required, and with 3000 pounds, 8 per cent. As the cubic capacity of the set was 107,200 cubic feet, the following represents the pounds sulphur, per cent nitre, and cubic feet per pound sulphur:—

Pounds Sulphur.	Per cent Nitre.		Cubic ft. per pound Sulphur.
4000	10	=	26·8
3600	9	=	29·8
3000	8	=	35·7

Several years after this the capacity was nearly doubled by the addition of two more chambers, the whole being run in one set, with a Gay-Lussac and Glover—still burning brimstone. The total number of cubic feet was now 202,600, the towers and connecting pipes not being included. Sulphur charged was about 10,500 pounds a day, per cent nitre from 3 to 3½.

The following gives the totals of four weeks running (28 days), being a fair illustration of the working of the chambers when in good condition:—

Total sulphur burned	295,265 lbs.
,, nitre potted	10,005 ,,
No. of blow-ups of nitrous acid run through the Glover	325 ,,

Dividing these figures by 28, we get as the daily average:—

Sulphur burned	10,545 lbs.
Nitre potted	357 ,,
Blow-ups of nitrous vitriol through the Glover	11·61 lbs.

The test of this nitrous vitriol was made with permanganate, using 5 c.c. of solution, containing 15·8 grms. $KMnO_4$ per litre (= ½ normal).

The nitrous vitriol was run into this from a graduated pipette, the volume required varying from 1·2 to 1·5 c.c. Adding up the total tests made in the above 28 days, I find that as a daily average 1·352 c.c. nitrous vitriol exactly decolourised the 5 c.c. of permanganate. It results from this that 100 pounds nitrous vitriol contains N_2O_3 equivalent to 4·62 pounds of chemically pure nitrate of soda. 11·61 blow-ups of this went daily through the Glover, each blow-up delivering 2334 pounds 1·7 specific gravity acid. Hence, total nitrous vitriol = 27,097 pounds at 4·62 per cent = 1252 pounds pure $NaNO_3$ = 1291 commercial 97 per cent nitrate.*

Hence the chambers were charged with nitre as follows:

From Glover	1291 lbs.
,, nitre pots	357 ,,
Total	1648 ,,

This 1648 pounds nitre = 15·62 per cent of the weight of the sulphur (10,545), and the chamber capacity (202,600 cubic feet) = 19·2 cubic feet per pound sulphur.

Combining this with results from old set of chambers, we have:—

Sulphur burned.	Per cent Nitre.	Cubic ft. per pound Sulphur.
4000	10	26·8
3600	9	29·8
3000	8	35·7
10,545	15·62	19·2

The above shows the proportion of the two variables, nitre and cubic feet per pound sulphur, under widely dif-

* A Paper read before the Chemical Section of the Franklin Institute, March 13, 1883.

* The acid after it had passed through the Glover was tested to see if it had any action on the $KMnO_4$, with practically negative results, proving that the acid had been completely denitrated, and was free from foreign reducing substances.

ferent circumstances; for the nitre varied from 8 to over 15½ per cent, and the cubic feet from 35·7 to 19·2, the increase of one being proportionate to the decrease of the other.

This being the case, the product obtained by multiplying the two together should be nearly a constant quantity, as follows:—

$$10 \times 26{\cdot}8 = 268$$
$$9 \times 29{\cdot}8 = 268$$
$$8 \times 35{\cdot}7 = 285$$
$$15{\cdot}62 \times 19{\cdot}2 = 300$$
$$\text{Mean} = 280$$

To give an illustration of the meaning of figure 280: a chamber with 280 cubic feet capacity per pound sulphur would require 1 per cent nitre, one with 140 cubic feet would require 2 per cent, with 28 cubic feet 10 per cent, with 14 cubic feet 20 per cent, and so on.

It is not to be expected that any formula based upon such changeable data as are furnished by the gases of an acid chamber will give absolutely unvarying results. Changes of the seasons, of the barometer, of temperature, of the direction of the wind, of the steam pressure, and from a hundred local sources, cause the result to vary within certain limits. Although the figures given above are derived only from this one particular set of chambers, and although it would be very interesting to have corroborative proof from other experiences, nevertheless it must be remembered that the above trials extended over a number of years, and were made under very widely different circumstances. They were made when the capacity was only about 100,000 cubic feet, and again when it was double this, when the chambers were running without towers, and later when both Gay-Lussac and Glover were present. Therefore, since in all these cases the resulting figures were closely accordant, they may be accepted by any manufacturer as a check upon the working of his chambers.

The chamber capacity in cubic feet, multiplied by the per cent nitre used, and divided by the number of pounds of sulphur burned daily, should give a result not far from 280, and all the better if it approaches to 300. If the result falls considerably below the former figure it is a pretty safe indication towards a low yield in acid, and a consequent loss in money.

ON ALGIN: A NEW SUBSTANCE OBTAINED FROM SOME OF THE COMMONER SPECIES OF MARINE ALGÆ.*

By EDWARD C. C. STANFORD, F.C.S.

(Concluded from p. 257).

IT is interesting to notice the way in which the salts come out, and analyses have been made with this view. The results are shown in the following tables:—Calcium sulphate and magnesium chloride are both present in the aqueous solution of the Laminaria and in the residue of the Fuci—carbonates generally in the salts of the Fuci and the residue of the Laminaria. In the latter, which is always submerged, the relation of the magnesium to the calcium is singularly like that existing in sea water.

Within certain limits the composition of the salts differ considerably, the age of the plant and the time of gathering both affecting it.

The following samples are from a considerable bulk of mixed salts evaporated:—

* Read before the Chemical Section of the Glasgow Philosophical Society, April 2, 1888.

ANALYSES OF THE SALTS.

	Laminaria stenophylla.	Fucus vesiculosus.
Calcium sulphate	1·69	4·33
Potassium sulphate	11·29	23·62
Potassium chloride	19·90	13·71
Sodium chloride	60·96	58·20
Magnesium chloride.. ..	4·35	—
Sodium carbonate	0·53	—
Sodium iodide,.	1·26	0·12
	99·98	99·98

In the following tables the composition of the salts are shown as they come out in six successive macerations in cold water.

The residues are always carbonised, and then washed and again ignited—that being the only way to insure perfect combustion in the presence of such an excess of saline constituents.

Laminaria stenophylla—Air-dried.
Containing 14·8 Moisture.

4 ozs. = 1750 grains. Six macerations in cold water; all evaporated, and residues weighed.

	Grs.	P. c.	Grs.	P. c.
1st water-weight of residue	288	16·45	499	= 28·5
2nd ,, ,,	211	12·05		
3rd ,, ,,	40	2·28	77·2	= 4·4
4th ,, ,,	37·2	2·12		
5th ,, ,,	21·1	1·20	39·7	= 2·26
6th ,, ,,	18·6	1·06		
	615·9 = 35·16 per cent.			

	1.	2.	3.	4.	5.	6.
Volatile matter	23·4	28·0	29·3	40·0	54·5	69·1
Salts	67·1	60·1	55·5	40·0	31·8	22·5
Fixed carbon..	3·91	4·97	4·1	4·56	2·23	0·96
Ash	5·59	6·93	11·1	15·44	11·4	7·44
	100·0	100·0	100·0	100·0	100·0	100·0

Composition of Salts.

	1.	2.	3.	4.	5.	6.
Calcium sulph.	2·91	1·02	Nil.	Nil.	Nil.	Nil.
Potass. sulph.	7·53	10·08	19·48	20·80	trace	trace
Potass. chlor.	34·05	30·95	24·81	23·78	,,	,,
Sodium chlor.	45·55	53·00	53·57	51·04	,,	,,
Sodium iodide	1·95	1·58	2·00	1·25	,,	,,
Sodium carb.	Nil.	Nil.	trace	3·30	,,	,,
Magnes. chlor.	8·55	3·40	trace	trace	,,	,,
	100·54	100·03	99·86	100·17	,,	,,

Laminaria stenophylla—Air-dried.
Calculated Percentage on Original Weed.

	Per cent.	Volatile.	Salts.	Carbon.	Ash.
1st Water ..	16·45	3·85	11·04	0·64	0·92
2nd ,, ..	12·05	3·35	7·26	0·60	0·84
3rd ,, ..	2·28	0·63	1·26	0·09	0·25
4th ,, ..	2·12	0·86	0·85	0·09	0·32
5th ,, ..	1·20	0·656	0·38	0·027	0·137
6th ,, ..	1·06	0·732	0·24	0·010	0·078
	35·16	10·128	21·03	1·457	2·545

Composition of Salts.

	1.	2.	3.	4.	5.	6	Total.
Calcium sulph.	0·321	0·074	Nil.	Nil.	Nil.	Nil.	0·395
Potass. sulph.	0·831	0·731	0·245	0·177	trace	trace	1·984
Potas. chloride	3·759	2·247	0·312	0·202	,,	,,	6·520
Sodium chlor.	4·970	3·846	0·678	0·432	,,	,,	9·926
Sodium iodide	0·215	0·115	0·025	0·011	,,	,,	0·366
Sodium carb.	Nil.	Nil.	trace	0·028	,,	,,	0·028
Magnes. chlor.	0·944	0·247	trace	trace	,,	,,	1·191
	11·040	7·260	1·260	0·850	0·38	0·24	21·030

Laminaria stenophylla—Air-dried.
Residual weed—Weight 2 ozs., or 50 per cent.

		Calculated on original weed, per cent.
Volatile matter	74·2	37·1
Charcoal	25·8	12·9
	100·0	50·0
Charcoal.		
Salts	18·0	2·32
Fixed carbon	50·7	6·55
Ash	31·3	4·03
	100·0	12·90
Salts.		
Potassium sulphate ..	35·27	0·818
Potassium chloride ..	6·72	0·156
Potassium carbonate ..	5·00	0·116
Sodium carbonate.. ..	49·97	1·169
Sodium iodide	2·63	0·061
Alkaline earths	Nil.	Nil.
	99·49	2·320

Fucus vesiculosus—Dried.
Containing 2·11 per cent Moisture.

4 ozs. = 1750 grs. Six macerations in cold water—all evaporated, and residues weighed.

		Grs.		Per cent.	
1st water	weight of residue	174·5		= 9·45	11·90
2nd	,, ,,	43·0		= 2·45	
3rd	,, ,,	11·2	0·64	= 0·99	
4th	,, ,,	6·15	0·35		
5th	,, ,,	trace			
6th	,, ,,	trace			
		234·85		= 12·89	

	1.	2.	3.	4.
Volatile matter, &c.	37·78	68·4	47·48	62·86
Salts	49·03	27 62	29·22	25·71
Fixed carbon	8·09	1·17	3·78	0·74
Ash..	5·10	2·81	19·52	10 69
	100·00	100·00	100·00	100·00

Salts.

	1.	2.	3.	4.
Potassium sulphate ..	27·25	48·19	trace	trace
Sodium sulphate	4·03	0·57	,,	,,
Sodium chloride	61·50	37·62	,,	,,
Sodium iodide	0·026	0·02	,,	,,
Sodium carbonate ..	7·42	13·36	,,	,,
	100·226	99·76	,,	,,

**Fucus vesiculosus—Dried.*
Calculated on original Weed.

	Per cent.	Volatile.	Salts.	Carbon.	Ash.
1st Water ..	9·45	3·58	4·63	0·76	0·48
2nd ,, ..	2·45	1·68	0·67	0·03	0·07
5rd ,, ..	0·64	0·304	0·187	0·024	0·125
4th ,, ..	0·35	0·221	0·089	0·003	0·037
5th, trace ..	—	—	—	—	—
6th, trace ..	—	—	—	—	—
	12·890	5·785	5·576	0·817	0·712

* This specimen was abnormally low in salts

Composition of Salts.

	1.	2.	3.	4.	Total.
Potas. sulphate	1·262	0·343	trace	trace	1·605
Sodium ,,	0·186	0·004	,,	,,	0·190
Sodium chloride	2·8378	0·2337	,,	,,	3·0715
Sodium iodide	0·0012	0·00013	,,	,,	0·00133
Sodium carbnt.	0·343	0·0895	,,	,,	0·4325
	4·630	0·6700	0·187	0·089	5·576

Residual Weed—Fucus vesiculosus.
Weight, 3 ozs. 175 grains = 85 per cent.

		Calculated on original weed.
Volatile matter	65·65	55·81
Charcoal	34·35	29·19
	100·00	85·00
Charcoal.		
Salts	18·63	5·24
Fixed carbon	58·53	17·53
Ash	22·84	6·42
	100·00	29·19
Salts.		
Potassium sulphate	29·41	1·5420
Sodium sulphate	47·58	2·5030
Calcium sulphate	9·34	0·4760
Magnesium sulphate	11·76	0·6160
Magnesium chloride	1·30	0·0680
Sodium carbonate	0·45	0·0235
Sodium iodide..	0·22	0·0115
	100·06	5·2400

After the salts have been removed, the weed is bleached by a weak solution of chlorinated lime, about 2° Tw. The Laminaria bleaches easily in a few hours, but the Fuci require prolonged and repeated treatment. I will call attention to the extreme beauty of some of the algæ before you when thus bleached, even in the common Fucus vesiculosus, or black wrack; you can trace the spores in the cells and the lining of the air-vessels. The specimen of Sargassum bocciferum (gulf weed) is beautifully transparent. Other specimens shown are Laminaria digitata, stems and fronds, the former looking like sticks of ivory, L. stenophylla, Fucus nodosus, F. serratus, Aliaria esculenta, Halidryes siliquosa, Rhodomenia palmata, Rhodomela pinnastroides, Zostera marina, Enteromorpha compressa, &c. When sufficiently white, the weed is soured by a very weak solution of sulphuric or hydrochloric acid, and well washed. If the acid be added with the bleach the action is quicker. It is then acted on in the cold by about a tenth of its weight of sodium carbonate for 24 hours, then heated, filtered, and evaporated. The residual cellulose is pressed into cakes for use as a paper material. It is already bleached, and has only to be put at once into the paper beater. There are plenty of fibrous materials in the market, but there is no real substitute for rags, as, I believe, this will, to a great extent, prove to be.

The whole of the plant is thus accounted for; in the Laminaria the average yield is as follows:—

On the air-dried plant—	
Extracted by water	30
Extracted by acid	5
Extracted by sodium carbonate = Algin	35
Cellulose	10
Moisture	20
	100

This plant is the only one now employed in making kelp; the least exposure to rain washes out the salts, and renders it useless for this purpose. It does not, however, interfere with its use for extracting the Algin, which is insoluble in water. For this purpose, if the salts are sacrificed, it is improved by exposure to rain and light. The wet weed, however, keeps perfectly well if access of air be prevented, for instance in a properly constructed "Silo," and there is no reason that any of it should be lost.

Applications of Algin.

Algin has properties which should make it useful for several applications in the soluble form. As a stiffener of fabrics, although not so rigid as starch, it fills the cloth

better, is tougher, more elastic, and more transparent. It mixes in all proportions with starch and dextrine, and imparts to the mixture these properties. Unbleached, it forms a cheap material for dressing winseys and such dark goods. Passed through an acid bath, the coating becomes glossy and insoluble, and thus a vegetable mordant is available for dyeing. Lime-water, and salts of calcium, barium, and several metallic salts, may be employed for a similar purpose, one of its peculiarities being the ease with which it is rendered insoluble.

I shall only just refer to its probable value as a food material on account of its nitrogenous character, as I have no edible specimens on the table which can be passed round for immediate consumption. As a cattle food there is a large opening for such a material. The agglutinating power of algin enables us to convert ino solid blocks many substances which are with difficulty made to cohere. Silica, lime, magnesia, oxide of zinc, phosphate of lime, alumina, chalk plunbago, charcoal, and many other such substances can be converted into solid hard blocks. All of these and many more are exhibited. Some of these compounds may be made by mixing the algin with a solution, where both form a joint precipitate with another solution—*e.g.*, sodium silicate and calcium chloride. One application of this agglutinating character has already assumed importance. Charcoal has been long known as our best solid non-conductor of heat, and no doubt it would have been employed long ago as a covering for our steam-boilers had any medium been known capable of agglutinating it. That is now attained by this substance. My "carbon cement,"* for this purpose, contains 97 per cent of charcoal, 3 per cent. of algin being sufficient to make it cohere; and as that charcoal is made from sea-weed, it is a remarkable fact that the whole covering is derived from that material. My friend Mr. Spiller, a high authority on the subject, has also found the solution of algin the best thing yet discovered for arresting incrustation in steam-boilers. We are not much troubled with this in Glasgow, but in the south, where the waters are hard, many such fluids are employed. Most of these are organic compounds combined with alkalies. One of the earliest and best was introduced some years ago by Mr. Spiller himself, and I am entirely indebted to him for suggesting the application of algin to this purpose. He speaks of it as highly efficient in precipitating the lime in such a fine state of division that it can easily be blown off from the cock. So that we now propose sea-weed in one form or another as a most comfortable internal and external application to our steam-boilers. In fact several large steamers are already ploughing the ocean, assisted in their daily conflicts with heavy seas by weapons borrowed from these opponents.

The insoluble form of algin is very like horn, and as it can be pressed into moulds of any size it may be used instead of that article.

It also appears to be an excellent non-conductor of electricity, and in combination with certain other substances may assist in providing the cheap non-conducting material, which shall be impervious to moisture, now so much required for underground telegraph and telephone wires.

It is an efficient agent for emulsifying oils, and, being coagulated by alcohol, for fining wines and spirits.

These are some of the probable applications of algin, and, seeing that the substance is new, and the source abundant, I shall not be bold enough to predict what it may *not* be used for.

Phosphorus Sesqui-sulphide.—M. Isambert.—The author has succeeded in obtaining this compound from ordinary phosphorus. It had been previously prepared from red phosphorus by M. Lemoine.—*Comptes Rendus.*

* Carbon cement forms a very light, inodorous, and cheap material for covering steam boilers. Over 20,000 square feet have already been applied to boilers and piping.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, May 26th, 1883.

Prof. CLIFTON, President, in the Chair.

MR. G. GRIFFITH read a paper "*On the Graphical Representation of Musical Intervals*," in which he gave an account of previous attempts to represent musical intervals in a graphical manner, and exhibited an enlargement of a diagram published by Dr. Pole, in Sir F. Ouseley's "Treatise on Harmony." In this diagram the musical intervals contained in one octave are represented by the differences between the logarithms of the vibration-numbers forming them. Mr. Griffith proposes to apply this principle to the whole musical scale. Retaining the lines used in ordinary music he inserts a faint line between these at unequal distances to represent the tones and semi-tones. Several diagrams were exhibited in which this principle was applied to the representation of intervals to the sequence of the keys in the major diatonic scale and to actual music.

Mr. W. G. BLAKELY and Dr. COFFIN considered that it would be a great help to students to have the method proposed. Mr. Blakely considered that it combined the advantages of the tonic sol-fa and ordinary notation. Dr. Coffin thought that it might become generally used.

A paper by Dr. J. FLEMING "*On a Phenomenon of Molecular Radiation in Incandescent Lamps*," was read. When the carbon filament in an Edison lamp volatilises, the vapour is condensed on the glass in a cloud. When the copper electrode is volatilised the copper is likewise deposited, but there is a bare space or line left on the glass in the plane of the filament, forming, as it were, a shadow of the filament. Dr. Fleming explains this on the supposition that the copper particles are thrown off in straight lines, as in a Crookes's vacuum. This shadow is not noticed in the carbon deposits. Dr. Fleming also remarks that the colour of a thin copper film is the same as a thin layer of gold in transmitted light.

Mr. W. BAILY read a paper on "*An Illustration on the Crossing of Rays.*" He took the case of three rays of homogeneous light of the same intensity and parallel to one plane, and polarised so that the vibrations were also parallel to the plane; and he exhibited and explained diagrams showing the motion which would occur under the circumstances.

Prof. F. GUTHRIE exhibited one of Chladni's plates bearing a striking resemblance to one of these figures.

Mr. BAILY thought the analogy might be a real one.

Professor CLIFTON described an improvement which he had made in the glass insulating stem he had exhibited to the Society on a former occasion. This stem had a glass cup encircling it and of a piece with the stem. Sulphuric acid was put into the cup. The new pattern had a hole formed into the bottom of the cup, and the upper part of the stem fitted into this hole like a stopper. It could thus be removed at will, and the acid renewed.

Professor AYRTON stated that he had used a similar arrangement for nearly two years, a narrow-necked glass bottle taking the place in the cup.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, June 4, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

MR. George Claudius Ash and Mr. Henry Swainson Cowper were elected Members of the Royal Institution.

The Managers reported that they had re-appointed

Professor James Dewar, M.A., F.R.S., as Fullerian Professor of Chemistry.

Two Candidates for Membership were proposed for Election.

The presents received since the lasl Meeting were laid on the table, and the thanks of the Members returned for the same.

NOTICES OF BOOKS.

Manual of Assaying Gold, Silver, Copper, and Lead Ores. By Walter Lee Brown, B.Sc. Chicago: Jansen McClurg and Co. 1883.

This little manual cannot in any sense be termed a scientific work on the subject of which it treats, nor indeed has the author attempted to make it such: the object has been to furnish a guide to those who, having had no previous technical, or especially scientific, education, desired to learn something of the practical assaying of gold and silver ores. In this respect the book will form an excellent elementary guide to the important art of assaying.

In the first chapters the essential tools required by the assayer in his operations are figured and described, such as tongs, crucibles, and cupels, including several forms of furnaces adapted for the employment of liquid fuel as a source of heat, and which are not yet, so far as we are aware, to be found in use in this country. The processes for testing the reagents and fluxes employed in the operations, and the estimation of silver in litharge and lead, necessary for the correction to be applied when these substances are employed, are clearly described.

The instructions contained in the chapter on the assaying of gold and silver ores by the scorification and crucible processes are in every respect of a thoroughly practical kind, and we think with these before him it would be difficult for even a beginner to go wrong, each operation being explained, what to expect, and the inferences to be drawn from the appearance of the crucible, cupel, or metallic bead.

The account of the dry assay of copper ores might, in our opinion, have been omitted except in so far as affording the student instruction in furnace manipulation, as those who have had any experience in the subject can understand how very little of practical utility can be compressed into four pages of very wide print. For the estimation of sulphuretted lead ores the well-known "tenpenny" nail method is given, but no mention is made of the use of iron pots, which would have been of interest to the student.

In a lengthy appendix a heap of miscellaneous information is brought together concerning assaying, which will be of much service. Luckow's electrolytic method for copper is here given, but no account is made of Gay-Lussac's "wet" process for silver, nor is there any mention of the necessity for "checks" being employed in assaying bullion.

In spite of the few faults we have to find with this book we feel sure that the lucid manner in which the operations are described will render it of considerable value to the practical metallurgist and assayer.

New Method for the Synthesis of the Alkyl-nitrous Acids.—G. Chancel.—Nitric acid, when acting directly upon an alkylic derivative of acetylacetic ether, produces alkyl-nitrous acid. Thus, the methylic, ethylic, and propylic derivatives of acetylacetic ether, when submitted to the action of nitric acid, yield, respectively, ethyl-nitrous, propyl-nitrous, and butyl-nitrous acids, which are the compounds designated by M. Victor Meyer as dinitro-ethane, dinitro-propane, and dinitro-butane. The nitric acid used should be of about 1·35 sp. gr., and only small quantities should be acted on at once.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 21, May 21, 1883.

Critical Point of the Liquefiable Gases.—J. Jamin.—This paper will, if possible, be inserted at length.

Composition of Combustible Mineral Substances.—M. Boussingault.—The author gives an account of the bitumen of the "fire-wells" at Ho-Tsing, in the Chinese province of Szetchuan, of the bitumen of Judea, of the fossil resins of the auriferous alluvium of New Granada, the coal of Canoas, near Bogota, the anthracites of Chili and New Granada.

Treatment of Waters derived from Washing Wools.—MM. Delattre.—The waters are first treated with a mixture of hydrochloric acid and ferric chloride to liberate the fatty acids, which are then skimmed off. The residual acid water is then treated with milk of lime, which precipitates certain impurities.

Deformation of Polarised Electrodes.—M. Gouy.—The author's experiments prove that a mechanical effect is produced upon solid electrodes by polarisation. When formed of a slender metallic plate they are deflected.

Electro-dynamic Interference of Alternate Currents.—A. Oberbeck.—A claim of priority as against M. Brillouin.

Certain Double Salts of Lead.—G. André.—The author has obtained a third lead-ammonium chloride (see *Comptes Rendus*, xcvi., p. 435). The double chlorides prepared by digesting litharge in a solution of ammonium chloride contain a small quantity of lead oxychloride. Certain double bromides have been obtained in the same manner.

Solubility of Strychnine in Acids.—MM. Hanriot and Blarez.—Strychnine dissolves with difficulty in acids, the solubility being greater as the acid is more dilute. If a concentrated solution of a neutral salt of strychnine is treated with a small excess of acid, there is formed a precipitate. The authors have studied in detail the behaviour of strychnine with the sulphuric and hydrochloric acids.

A Saccharine Substance obtained from the Lungs and the Sputa of Phthisical Patients.—A. G. Pouchet.—The compound obtained is represented by the formula $C_{12}H_{18}O_9,H_2O$.

Zymase of Human Milk.—A. Béchamp.—The caseine of human milk is not absolutely identical with that of cows' milk. The zymase of human milk fluidifies and saccharifies starch-paste almost as intensely as diastase or human dialozymase. The rotatory power of this zymase is much greater than that of the galacto-zymase of the cow.

Bulletin de la Société Chimique de Paris. No. 8, April 20, 1883.

Study on the Combustion of Explosive Gaseous Mixtures.—MM. Mallard and Le Chatelier.—Continued from pp. 2, 98, and 268 of the present volume. The author examines the speed of propagation of the flame, the influence of the diameter of the tubes, and of vibratory movements; the results of experiments with mixtures of formene and air, of hydrogen and air, coal-gas and air; carbon monoxide and oxygen, hydrogen and chlorine, and hydrogen and oxygen.

Numerical Relations between Thermic Data.—D. Tommasi.—Already noticed in the *Comptes Rendus.*

A Special Form of Gas-holders.—Dr. L. G. de Saint Martin.—This memoir cannot be reproduced without the five accompanying illustrations.

Law of Thermic Substitution-constants.—D. Tommasi.—The author upholds the exactitude of his law by comparing the combination-heats of a number of compounds as determined experimentally with those calculated by his law.

Researches on the Passage of Alcoholic Liquors through Porous Bodies (Second Notice).—H. Gal.—The author has studied the influence of temperature on this phenomenon. He finds that alcohol in bladders and exposed to temperatures of $-10°$, lost strength as decidedly as at $+50°$, though more slowly. An increase of strength is observed only when the bladders were placed in a medium where watery vapour was absorbed by quicklime. The nature of the membrane, as gold-beater's skin or parchment, had no effect save upon the speed of the evaporation.

Hydrates of Chlorine.—E. Maumené.—This paper has been already communicated to the Chemical News by the author.

Ammoniacal Bromides and Oxy-bromides of Zinc.—G. André.

Salts formed by Glycolic Acid.—R. de Forcrand.—These two papers have been already noticed.

Oil of Angelica of the Roots.—Laurent Naudin.—Already noticed.

Notes on the Soda Industry.—A. Scheurer-Kestner.—In this bulky memoir the author treats in succession of the loss of soda in the manufacture by the Le Blanc process; of the presence of vanadium, fluorine, and phosphorus in the lixivium of crude soda; of the preparation of caustic soda and the causes of loss; of the more economical use of fuel; the use of pyrites in the manufacture of sulphuric acid, and of the importance of the soda manufacture.

Cosmos Les Mondes.
Tome v., No. 1, May 5, 1883.

The Compound Incorrectly Named Chlorine Hydrate.—E. Maumené.—Already inserted.

Combination Calories of the Soluble Compounds of Zinc.—Dr. T. Tommasi.—Already noticed.

May 12, 1883.

This number contains no original chemical matter.

MEETINGS FOR THE WEEK.

Tuesday, 12th.—Royal Medical and Chirurgical, 8.30.
—— Photographic, 8.
Wednesday, 13th.—Microscopical, 8.
Thursday, 14th.—Royal, 4.30.
—— Philosophical Club, 6.30.

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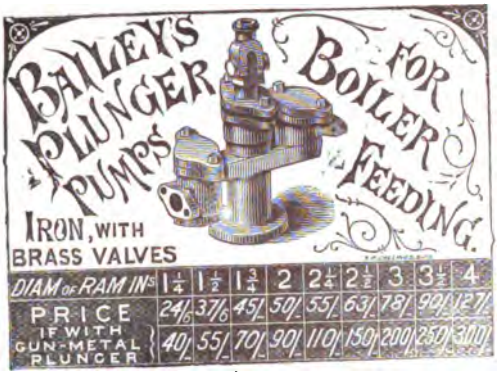

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1229.

ON THE QUALITATIVE SEPARATION OF ZINC, NICKEL, AND COBALT.

By OSCAR C. S. CARTER.

THIS separation is based on well-known reactions of Zn, Ni, and Co with various reagents. The advantages over the usual method of separation are that you avoid the oxidation of NiS and CoS, and hence obtain perfectly clean and clear filtrates, and complete precipitation is insured, and the separation is rapid and conclusive.

Separation.

Treat a solution of the chlorides with Br water and NaOH in excess in the cold; the Ni and Co are precipitated as hydrated sesquioxides $Ni_2(OH)_6$ and $Co_2(OH)_6$ (black), which settle rapidly. The hydrate of zinc $Zn(H_2O_2)$ goes in solution in the excess of NaOH as Na_2ZnO_2 (sodium zincate); filter; from the filtrate the Zn is completely precipitated as ZnS with $(NH_4)_2S$, clean and white.

Dissolve the hydrates of Ni and Co in HCl, and add NH_4HO until alkaline, and then ferricyanide of potassium. The presence of the Co is at once made known by the well-known blood-red colouration that ferricyanide gives with salts of Co, similar in appearance to $Fe_2(CNS)_6$. On boiling the solution the Ni is precipitated as a copper-red precipitate, while the red colour of the Co solution remains unchanged. Filter off the precipitated Ni, and in the filtrate the Co remains, which can be completely precipitated with $(NH_4)_2S$ as CoS, and still further recognised by the blue colour it imparts to a borax bead.

In this separation the Br oxidises the $Ni(OH)_2$ and $Co(OH)_2$ to $Ni_2(OH)_6$ and $Co_2(OH)_6$, which settle quicker and can be filtered more rapidly, and it seems to have no effect on the Zn.

The Br water and NaOH are added in the cold, because at 50° C. about three times as much alkali solution is required to dissolve $Zn(OH)_2$ as at 17° C. (*Journ. Am. Chem. Soc.*, February, 1880, ii., 29), and if the solution were boiled, zinc oxide would separate from dilute solutions; hence concentrated solutions of NaOH or KOH must be used.

The addition of an alkali solution so dilute as 1-10th normal in case of KOH will not dissolve $Zn(OH)_2$, however much is added. NaOH is not required in so large excess to dissolve $Zn(OH)_2$ as KOH is. The entire separation can be performed in one and a half hours.

Laboratory High School, Philadelphia.

ON A NEW METHOD OF DETERMINING SULPHUR IN ORGANIC SUBSTANCES.

By PETER CLAESSON.

THE author, after criticising previous methods, describes his own process, depending on the complete oxidation of the substances in a mixed current of oxygen and nitric oxide. The apparatus is fitted up as follows:—One end of the combustion tube, which is rather longer than the combustion-furnace, is drawn out to a tube 20 c.m. long and ½ c.m. wide. The drawn out portion is bent at an obtuse angle. At the same time are made four rolls of platinum wire-gauze, each about 7 c.m. long. The nitric oxide gas is prepared from copper and ordinary nitric acid in a Kipp apparatus. The gas delivery-tube with its cock is best ground in. A caoutchouc tube may be substituted, but before being used it must be dipped in melting paraffin, and immediately inserted in the apparatus. Nitric oxide gas is evolved in such an apparatus as quietly and regularly as carbonic acid or hydrogen. After use the acid is poured out of the apparatus, as the copper is somewhat attacked by the fumes even when the apparatus is closed. The apparatus is emptied through a cock ground in the lower vessel. The same acid may be used in such an apparatus eight or ten times. Both the oxygen and the nitric oxide must be passed through washing bottles filled with water. When the caoutchouc tube connecting the nitric oxide apparatus with the washing bottle is well moistened before use it is but little attacked.

The combustion-tube is charged as follows:—After the bend comes a platinum roll; then, and at the distance of about 10 c.m., a boat with fuming nitric acid. The boat is best thrust half-way into the tube, filled with acid by means of a pipette, and thrust into its place. At about 10 c.m. from the boat follows a second platinum roll, and 5 c.m. from that the third. Immediately after this follows a boat with the substance, and then the last platinum roll. The fork-shaped delivery tube is connected with the combustion-tube by means of a cork, and with the washing-bottles by means of flexible tubing. The drawn-out and bent end of the combustion-tube passes into a small flask holding about 100 c.c. This flask serves as a receiver, and contains water enough to close the aperture of the tube. The boat with the nitric acid is at the beginning of the operation protected, if necessary, from too strong evaporation. A moderate current of about equal quantities of oxygen and nitric oxide is allowed to stream through the tube. The contents of the tube soon become red. The platinum rolls before and behind the boat with nitric acid are also gently ignited. When this point is reached the roll before the substance is also heated to redness. This is especially important when volatile substances such as hydrosulphates or sulphides are burnt, because the primary oxidation products are very apt to draw back. The combustion is now carried on as in an ultimate analysis, progressing slowly backwards. The colour of the tube between the two boats serves as an indicator. If no colour is perceived it is a sign that all available oxygen is consumed, and the combustion must be retarded. The nitric acid in the boat serves as a reserve. The hot gases which sweep over convey always with them sufficient oxygen compounds to burn unconsumed portions at the last roll. When the gases at their exit from the tube appear red during the entire combustion we may be certain that the process was complete.

Readily volatile compounds are enclosed in small glass globes, and if extremely volatile two boats with nitric acid are placed, the one close behind the other. If the combustion is conducted slowly enough no phenomena of ignition take place, but the process can be much accelerated without danger. These phenomena are not attended with explosions, but a faintly luminous flame moves slowly between the platinum roll and the boat and ignites the substance. If this takes place the gas-taps are closed for a moment, and the flame expires at once. With aromatic substances, especially naphthaline compounds, it may occur that the substance is first nitrised, and then burns like tinder. Even in this case no unburnt matter passes through the last platinum roll if there is sufficient nitric acid in the boat. It is the general rule that the more rapid the combustion the more nitric acid is required, and inversely. When everything in the boat is burnt we proceed with the heating until both the nitric acid and the sulphuric acid formed have distilled over into the receiver. Sometimes, though very seldom, dark drops are deposited near the nitric acid boat. These contain nitro-compounds of sulphuric acid, which on heating evolve nitric oxide. If the tube contains an excess of oxygen condensation sets in, which inevitably occasions a violent regurgitation of the water in the receiver. If, therefore, such drops appear only nitric oxide is allowed to pass over at the beginning

of the distillation of the nitric acid. In any case oxygen alone is finally passed through until the interior of the tube is colourless. When the flame goes out oxygen is still passed through for a short time, one of the washing-bottles is detached from the tube, and the whole is let become quite cold. The contents of the receiver are poured into a porcelain capsule; the tube and the receiver are washed with water till the reaction of sulphuric acid is no longer to be recognised; the whole is evaporated to dryness on the water-bath, and the sulphuric acid is determined as usual. The tube is best washed as follows:—After the receiver is removed the drawn-out end of the tube is rinsed with water, and it is then fitted with a flexible tube, pinchcock, and jet like a burette. The platinum rolls are shaken out; water is let in and emptied through the pinchcock into the capsule, repeating this process till the tube is free from sulphuric acid.—*Zeitschrift fur Analytische Chemie.*

ON THE

PREPARATION OF LÆVO-TARTARIC ACID.*

By Dr. G. GORE, F.R.S.

As I believe there exists no accurate and complete description in English of the best process for preparing this remarkable substance (discovered by M. Pasteur), I beg leave to communicate to the Birmingham Philosophical Society the following account of its preparation, received by me (January, 1882) from my friend M. Jungfleisch.

"We prepare at the outset the double racemate of sodium and ammonium; we divide a portion of racemic acid into two exactly equal parts by weight; we exactly neutralise the first portion (dissolved in boiling water) by means of pure carbonate of sodium; then the second by ammonia; and finally, we mix the two liquids, and filter the mixture if necessary. It remains then to evaporate the solution in a hot water bath until it possesses the requisite concentration. That concentration is necessarily variable with the temperature at which the crystallisation operates, and it will be more considerable in summer than in winter. In a general way that should be regulated in such a manner that by cooling, a litre of the solution deposits 150 to 160 grammes of the right and left-handed crystals. Basing upon this, it is easy to determine by two or three tentative essays the density which corresponds to the temperature of the laboratory. We find thus the determination to be made at the temperature of the water-bath, the numbers which vary between 1·24 for winter, and 1·28 for summer.

"This treatment renders necessary that the evaporation of the liquors be repeated a large number of times; or the employment of hydrometers is a little advantageous for following that operation and recognising when the heated solution has attained the necessary density. It will be better to adopt the following process:—

"We prepare a liquid which presents the necessary density (a mixture of water and sulphuric acid, for example), and into it plunge a little hollow bead of glass, which is ballasted just so that its point is level to the surface; we seal at once that point by the flame of a lamp. This little apparatus, placed in the saline solution to be evaporated, sinks for a time to the bottom of the capsule; meanwhile, the water disappearing little by little, will the point mount to the surface of the liquid possessing the density for which the float has been regulated. The very small volume of the little bottle permits the operation at all times upon the smallest quantities of liquid, which always are on hand at the end of each treatment.

"During the evaporation, a portion of the ammonia escapes with the vapour of water; it is necessary to replace this when the operation is finished. An excess of that alkali favours the crystallisation when added in quantity sufficient to give a reaction freely alkaline.

"The solution made alkaline, and possessing the requisite density, is poured into a crystalliser having roughened edges, which is covered immediately with a ground glass plate accurately closing it. The vapour of water emitted by the hot liquid in its condensation wets the glass at the edges of the crystalliser, and forms between them by capillarity a kind of hydraulic closure which permits the liquid to entirely cool in undisturbed supersaturation. We must always take care to place the vase in a place whereof the temperature is nearly constant, or at least not presenting during the day and the night a digression very considerable.

"The next day, the solution having acquired the atmospheric temperature, we wet our hands carefully, we take between the fingers a small fragment of the right-handed tartrate of sodium and ammonium, we wash it by submitting it for a moment to a jet of water from a wash bottle, and, lifting the sheet of glass, we allow it to fall into the right hand part of the crystalliser. We do the same with a fragment of the left-handed salt, which we allow to fall upon the left, and we replace immediately the sheet of glass. The two crystals occupy thus almost the middle of two radii, situated on the prolongation of the one by the other. It is necessary to avoid the introduction of all crystalline dust, which determines rapidly a confused crystallisation. The wet crystals reproduce not the same phenomena; they make suitable, in some manner, the liquid bed which envelops them; they increase with slowness, and do not attain until after two or three days their greatest maximum; they remain perfectly isolated when we operate properly, and the crystals upon the right contain nothing but dextro-tartrate, whilst those on the left are formed exclusively of left. It is easy to obtain thus crystals clear isolated, weighing each 180 to 200 grammes. When they cease to accrete, we lift or we drain them, and after having restored by concentration the liquid to requisite density we repeat the same operation a second time, and a third, and so on to complete exhaustion of the solution.

"It is advantageous to operate in crystallisers containing one to two litres of liquid. In larger vessels the quantity of salt to deposit being considerable, a variation of the temperature may provoke the deposition of multiple crystals, which disturbs the cleanliness of the result. We may, it is true, suppress that inconvenience by introducing into the supersaturated solution several (or many) fragments of each species.

"The right and left handed crystals having been separated, we dissolve by means of a water-bath the lævo-tartrate in the least possible quantity of water, we add a slight excess of ammonia, and we allow the liquid to cool, agitating it in order to disturb the crystallisation; we dry in the open air the crystalline pulp obtained; we wash it rapidly in a funnel by means of a small quantity of cold water, and we repeat many times these operations, until the crystals obtained are pure. These last may then be transformed into a salt of calcium, next into lævo-tartaric acid. The wash-waters arising from the purification furnish additional lævo-tartrate to purify, then the mother waters which we add to the liquors to be separated."

Racemic acid may be obtained at a very moderate price from the original makers, MM. Wagenmann, Seybel, and Co. (Fabrik Chem. Producte in Liesing bei Wien) IV. Resselgasse 5, Vienna, who obtain the raw material from the wine district near Thann and Mulhouse, and separate the acid from time to time in their tartaric acid manufactory. The only persons of whom I have been able to obtain the lævo-acid ready prepared are MM. Billault et Billaudot, Pharmaciens, 22, Rue de la Sorbonne, Paris. I was favoured with their address by M. Pasteur.—(G. G.).

* Reprinted from the *Proceedings of the Birmingham Philosophical Society*, vol. iii., p. 325.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

OXYGEN.

THE ratio between oxygen and hydrogen is the foundation upon which the entire system of atomic weights depends. Hence, the accuracy of its determination has, from the beginning, been recognised as of extreme importance. A trifling error here may become cumulative when repeated through a moderate series of other ratios.

Leaving out of account the earliest researches, which have now only a historical value, we find that three methods have been employed for fixing this important constant. First, the synthesis of water, effected by passing hydrogen gas over red-hot oxide of copper. Secondly, the exact determination of the relative density of the two gases. Thirdly, by weighing the quantity of water formed upon the direct union of a known volume of hydrogen with oxygen.

The first of these methods has been employed in three leading investigations, namely, by Dulong and Berzelius,† by Dumas, and by Erdmann and Marchand. The essential features of the method are in all cases the same. Hydrogen gas is passed over heated oxide of copper, and the water thus formed is collected and weighed. From this weight and the loss of weight which the oxide undergoes, the exact composition of water is readily calculated. Dulong and Berzelius made but three experiments, with the following results for the percentages of oxygen and hydrogen in water:—

O.	H.
88·942	11·058
88·809	11·191
88·954	11·046

These figures, rather roughly determined, and by no means exact enough to meet the requirements of a modern science, give a mean value of 16·021 for the atomic weight of oxygen. As the weighings were not reduced to a vacuum, this correction was afterwards supplied by Clark,‡ who showed that these syntheses really make O = 15·894; or, in Berzelian terms, if O = 100, H = 12·583.

In 1842 Dumas§ published his elaborate investigation upon the composition of water. The first point was to get pure hydrogen. This gas, evolved from zinc and sulphuric acid, might contain oxides of nitrogen, sulphur dioxide, hydrosulphuric acid, and arsenic hydride. These impurities were removed in a series of wash bottles; the H_2S by a solution of lead nitrate, the H_3As by silver sulphate, and the others by caustic potash. Finally, the gas was dried by passing through sulphuric acid, or, in some of the experiments, over phosphorus pentoxide. The copper oxide was thoroughly dried, and the bulb containing it was weighed. By a current of dry hydrogen all the air was expelled from the apparatus, and then, for ten or twelve hours, the oxide of copper was heated to dull redness in a constant stream of the gas. The reduced copper was allowed to cool in an atmosphere of hydrogen. The weighings were made with the bulbs exhausted of air. The table (see next page) gives the results.

Column A contains the symbol of the drying substance. B gives the weight of the bulb and copper oxide. C, the weight of bulb and reduced copper. D, the weight of the vessel used for collecting the water. E, the same plus the water. F, the weight of oxygen. G, the weight of water formed. H, the crude equivalent of H when O = 10,000. I, the equivalent of H, corrected for the air contained in the sulphuric acid employed. This correction is not explained, and seems to be questionable.

In the sum total of these nineteen experiments, 840·161 grammes of oxygen form 945·439 grammes of water. This gives, in percentages, for the composition of water—Oxygen, 88·864; hydrogen, 11·136. Hence the atomic weight of oxygen, calculated in mass, is 15·9608. In the following column the values are given as deduced from the individual data given under the headings F and G:—

15·994
16·014
16·024
15·992
15·916
15·916
15·943
16·000
15·892
15·995
15·984
15·958
15·902
15·987
15·926
15 992
15·904
15·900
16·015

Mean .. 15·9607, with a probable error of ± 0·0070.

In calculating the above column several discrepancies were noted, probably due to misprints in the original memoir. On comparing columns B and C with F, or D and E with G, these anomalies chiefly appear. They were detected and carefully considered in the course of my own calculations, and, I believe, eliminated from the final result.

The paper by Erdmann and Marchand* followed closely after that of Dumas. The method of research was essentially the same as that of the latter chemist, varying only in points of comparatively unimportant detail. The results are given in two series, in one of which the weighings were not actually made in vacuo, but were, nevertheless, reduced to a vacuum standard. The second series represents actual vacuum weighings. The quantity of water formed in each experiment was from 41·664 to 95·612 grammes. I give below only the percentages of oxygen and hydrogen in water as deduced from Erdmann and Marchand's data:—

First Series.

O.	H.
88·836	11·164
88·821	11·179
88·874	11·126
88·868	11·132

Second Series.

O.	H.
88·887	11·113
88·898	11·102
88·895	11·105
88·899	11·101

Hence the atomic weight of oxygen is as follows:—

First Series.	Second Series.
15·915	15·997
15·891	16·015
15.976	16·010
15·966	16·016
Mean 15·9369 ± 0·0138	Mean 16·0095 ± 0·0030

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† Thomson's "Annals of Philosophy," July, 1821, p. 50.
‡ *Philosophical Magazine*, 3rd Series, 20, 341.
§ *Comptes Rendus*, 14, 537.

* *Journ. f. Prakt. Chem.*, 1842, Bd. 26, s. 461.

	A.	B.	C.	D.	E.	F.	G.	H.	I.
H_2SO_4	.. .. ..	291·985	278·806	480·807	495·634	13·179	14·827	1250·5	1249·6
,,	.. .. ..	344·548	324·186	488·227	511·132	20·362	22·905	1249·0	1248·0
,,	.. .. ..	316 671	296·175	439·711	462·764	20·495	23·053	1248·1	1247·2
P_2O_5	.. .. ..	625·829	568·825	884·190	948·323	57·004	64·044	1250·6	1249·0
H_2SO_4	.. .. ..	804·546	728·182	887·331	973·291	76·364	85·960	1256·2	1254·6
,,	.. .. ..	533·726	490·155	867·159	916·206	43·571	49·047	1256·3	1255·0
,,	.. .. ..	661·915	627·104	839·304	878·482	34·811	39·178	1254·6	1253·3
P_2O_5	.. .. ..	612·625	566·738	824·624	876·244	45·887	51·623	1250·0	1249·0
,,	.. .. ..	904·643	844·612	822·660	890·246	60·031	67·586	1258·3	1255·1
H_2SO_4	.. .. ..	642·325	590·487	741·095	799·417	51·838	58·320	1250·4	1248·9
P_2O_5	.. .. ..	587·645	535·137	874·832	933·910	52·508	59·078	1251·2	1249·0
,,	.. .. ..	673·280	613·492	931·487	998·700	59·789	67·282	1253·3	1250·8
H_2SO_4	.. .. ..	660·855	598·765	682·374	752·273	62·090	69·899	1257·7	1254·8
,,	.. .. ..	642·325	590·487	741·097	799·455	51·838	58·360	1258·1	1256·2
,,	.. .. ..	937·845	881·362	1064·762	1128·319	56·483	63·577	1255·3	1252·2
P_2O_5	.. .. ..	756·352	719·563	878·640	920·030	36·789	41·390	1250·6	1249·1
,,	.. .. ..	754·162	720·000	887·817	926·275	34·162	38·458	1257·3	1255·1
,,	.. .. ..	759·762	727·632	888·662	924·837	32·133	36·175	1257·5	1254·7
,,	.. .. ..	747·652	716·825	877·862	912·539	30·827	34·677	1248·8	1248·0
						Means		1253·3	1251·5

The effect of discussing these two series separately is somewhat startling. It gives to the four experiments in Erdmann and Marchand's second group a weight vastly greater than their other four and Dumas's nineteen taken together. For so great a superiority as this there is no adequate reason; and it is highly probable that it is due almost entirely to fortunate coincidences, rather than to greater accuracy of work. We will, therefore, treat Erdmann and Marchand's experiments as one series, giving all equal weight, and then combine them with the results obtained by Dumas. We now have—

By Dumas .. .. O = 15·9607 ± 0·0070
By Erdmann and Marchand O = 15·9733 ± 0·0113

General mean .. .. O = 15·9642 ± 0·0060

In discussing the relative density of oxygen and hydrogen gases we need only consider the more modern researches of Dumas and Boussingault, and of Regnault. As the older work has some historical value, I may in passing just cite its results. For the density of hydrogen we have 0·0769, Lavoisier; 0·0693, Thomson; 0·092, Cavendish; 0·0732, Biot and Arago; 0·0688, Dulong and Berzelius. For oxygen there are the following determinations: 1·087, Fourcroy, Vauquelin, and Séguin; 1·103, Kirwan; 1·128, Davy; 1·088, Allen and Pepys; 1·1036, Biot and Arago; 1·1117, Thomson; 1·1056, De Saussure; 1·1026, Dulong and Berzelius; 1·106, Buff; 1·1052, Wrede.*

In 1841 Dumas and Boussingault† published their determinations of gaseous densities. For hydrogen they obtained values ranging from 0·0691 to 0·0695; but beyond this mere statement they give no details. For oxygen three determinations were made, with the following results:—

1·1055
1·1058
1·1057

Mean .. 1·10567 ± 0·00006.

If we take the two extreme values given above for hydrogen, and regard them as the entire series, they give us a mean of 0·0693 ± 0·00013.

This mean hydrogen value, combined with the mean oxygen value, gives for the atomic weight of the latter element the number 15·9538 ± 0·031.

Regnault's researches, published four years later,‡ were of a more satisfactory kind. Indeed they are among the classics of physical science, and probably approach as near to absolute accuracy as is possible for experiment.

For hydrogen three determinations of density gave the following results:—

0·06923
0·06932
0·06924

Mean .. 0·069263 ± 0·000019.

For oxygen four determinations were made, but in the first one the gas was contaminated by traces of hydrogen, and the value obtained, 1·10525, was therefore rejected by Regnault as too low. The other three are as follows:—

1·10561
1·10564
1·10565

Mean .. 1·105633 ± 0·000008.

Now, combining the hydrogen and oxygen series, we have for the atomic weight of oxygen 15·9628 ± 0·0044.*

Upon combining the result of Regnault's work with that from Dumas and Boussingault's we get the following value:—

From Dumas and Boussingault O = 15·9538 ± 0·031
From Regnault .. .. O = 15·9628 ± 0·0044

General mean .. .. O = 15·9627 ± 0·0043

This result, it will be seen, agrees remarkably well with that obtained in the experiments upon the synthesis of water.

The third method indicated at the beginning of this discussion has been recently employed in part by J. Thomsen,† of Copenhagen. Unfortunately this chemist has not published the details of his work, but only the end results. These serve to confirm the values for oxygen fixed by other methods, but they cannot well be included in the systematic discussion. Partly by the oxidation of hydrogen over heated copper oxide, and partly by its direct union with oxygen, Thomsen finds that

* For Wrede's work see *Berzelius's Jahresbericht* for 1843. For Dulong and Berzelius, see the paper already cited. All the other determinations are taken from "Gmelin's Handbook," Cavendish edition, vol. i, p. 279.

† *Comptes Rendus*, xii., 1005. Compare also with Dumas, *Comptes Rendus*, xiv., 537.

‡ *Comptes Rendus*, xx., 975.

* Since these computations were made Prof. J. Le Conte has called my attention to the existence of slight numerical errors in Regnault's own reductions. As corrected by Le Conte, Regnault's figures give 1·105612 for the density of oxygen, and 0·069269 for that of hydrogen. Hence the atomic weight of O becomes 15·9611 instead of 15·9628. The difference is slight, but still it ought not to be ignored. All the computations in the body of this work, having been finished before I received Professor Le Conte's figures, must stand, nevertheless, as they are. For further details Le Conte refers to *Phil. Mag.* (4), 27, p. 29, 1864; and also to the "Smithsonian Report for 1878," p. 428.

† *Ber. d. Deutsch. Chem. Gesellschaft*, 1870, s. 928.

at the latitude of Copenhagen, and at sea level, 1 litre of dry hydrogen at 0° and 760 m.m. pressure will form 0·8041 gramme of water. According to Regnault, at this latitude, level, temperature, and pressure, a litre of hydrogen weighs 0·08954 gramme. From these data O = 15·9605. It will be seen at once that Thomsen's work depends in great part upon that of Regnault, and yet that it affords an admirable reinforcement of the latter.

It is now plain, in conclusion, that all the different lines of research point to an atomic weight for oxygen a little below 16·00. Five distinct investigations confirm each other wonderfully. Upon combining the values obtained by the two chief methods we get the following final results:—

From synthesis of water ..	O = 15·9642 ± 0·0060
From gaseous densities	O = 15·9627 ± 0·0043.

In the general mean the atomic weight of oxygen becomes 15·9633, with a probable error of ± 0·0035.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 7, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—J. T. Barr, L. L. Garbutt, C. W. Stephens, P. H. Wright.

The PRESIDENT expressed his regret that a sufficient number of Fellows was not present to enable a ballot to take place; he hoped that a ballot would be held at the next meeting on June 21, which would be the last meeting of the session.

Dr. GLADSTONE then communicated "*Laboratory Notes*," by J. H. GLADSTONE and A. TRIBE. 1. On the Action of Light and Heat on Cane- and Invert-Sugars.—The authors have investigated the action of their well-known copper-zinc couple on a 5 per cent solution of sugar. No carbonic acid was evolved at ordinary temperatures, but at 100° C. carbonic acid was formed, and a small quantity of a substance which gave the iodoform reaction on treatment with iodine and potassium hydrate; this substance also gave acetic acid on treatment with potassium chromate and sulphuric acid. It was therefore thought at first that alcohol had been produced from sugar; further investigation showed that the carbonic acid came from some oxycarbonate of zinc formed during the washing of the couple, while the reducing body was a product of the action of heat upon the sugar solution. Many experiments were made in which a 5 per cent solution of cane-sugar was heated for some days: in all cases the iodoform-yielding substance was formed, even in the absence of air. Some experiments were also made as to the influence of light, air, and atmospheric germs on the conversion of cane-sugar into glucose. The authors conclude that this conversion takes place with extreme slowness when the cane-sugar solution is exposed to the action of light and air, singly or jointly. Light appears to be detrimental to the development of fungoid growths in a solution of cane-sugar exposed to atmospheric air. 2. On Hydroxylamine.—The copper-zinc couple reduces the hydrochloride of this base, ammonia being formed. 3. On the Recovery of Iodine from Organic Iodide Residues.—The residues are poured on an excess of copper-zinc couple, wet with water or alcohol. Zinc iodide is formed, which is extracted with hot water. The iodine is obtained in the free state by the action of hydrochloric acid and bleaching-powder. 4. A Residual Phenomenon of the Electrolysis of Oil of Vitriol.—It was noticed that gas continued to be evolved from both the electrodes after the battery had been disconnected; this gas was oxygen. This phenomenon is probably due to the presence of Berthelot's persulphuric acid. 5. On an Alleged Test for Alcohol.—Davy suggests that traces of alcohol can be detected by the blue colour which is produced with a warm solution of molybdic anhydride in oil of vitriol. The authors find that many other reducing substances and sugar give the same reaction. 6. Reaction of the Copper-zinc Couple on Nitric Oxide.—When this gas is passed over the moist copper-zinc couple, ammonia, but no protoxide of nitrogen, is formed. Free nitrogen was substituted for nitric oxide, but no evidence as to the formation of ammonia could be obtained. 7. On the Reducing-action of Spongy Lead.—Spongy lead free from occluded hydrogen reduces nitrates to nitrites, ammonia being simultaneously formed. Spongy lead has no action upon an aqueous solution of potassium chlorate, but the addition of 1 per cent sulphuric acid causes a slow reduction to chloride. Lead filings cause similar reactions, but their activity is much less.

Mr. WARINGTON said the fact recorded by the authors that sugar solution when heated forms a reducing substance giving the iodoform reaction, was of great importance, and, moreover, threw some doubt on the conclusions drawn by Muntz as to the occurrence of alcohol in almost all natural waters, these conclusions depending on the iodoform reaction.

The SECRETARY then read the following "*Note on a Basic Ammonio-Copper Sulphate*," by S. U. PICKERING. The author stated in a previous paper (CHEMICAL NEWS, vol. xlvii., p. 182), that, on dilution, ammonio-copper sulphate solution throws down a basic precipitate containing only traces of ammonia. With strong solutions, however, different results are obtained. With nearly saturated solutions a violet blue substance is slowly deposited, which has the composition $4CuO,5SO_4 16NH_3$. When such a solution is diluted with a small quantity of water a violet-blue precipitate, $CuSO_4 3CuO 2NH_3 5H_2O$, is deposited.

"*Notes on Loew and Bokornig's Researches on the Probable Aldehydic Nature of Albumen*," by A. B. GRIFFITHS. The author states that he has gone over a good portion of the experiments which led the above chemists to their conclusions, and in the present paper details one or two observations he has noticed in the case of the protoplasm of *Spirogyra*. The protoplasm, whether dead or alive, reduces a dilute alkaline solution of a cupric salt. The living cells when treated with a weak solution of sodium chloride under the microscope, form crystals. The author is therefore inclined to think that the reducing body is a glucose, and, moreover, it must be dextrose, because levulose does not form a crystalline compound with sodium chloride. The author does not give any analysis, or say how the crystals were identified, but states that most likely they have the formula $C_6H_{12}O_6NaCl,H_2O$.

"*Note on the Action of Sulphuric Acid, Sp. gr. 1·84, upon Potassium Iodide*," by H. JACKSON. It has long been known that when strong sulphuric acid acts upon potassium iodide there are produced hydric sulphide, sulphur dioxide, iodine, hydriodic acid, hydrio-potassic sulphate, and water; but no details as to the amounts produced have been published. The author finds that two principal reactions occur. The first when the sulphuric acid is in large excess, when the reaction is—

$$2KI + 3H_2SO_4 = I_2 + SO_2 + 2HKSO_4 + 2H_2O.$$

The second when there is just sufficient sulphuric acid to satisfy the potassium iodide used,—

$$8KI + 9H_2SO_4 = I_8 + H_2S + 8KHSO_4 + 4H_2O.$$

To obtain these reactions perfectly it is necessary to have the sulphuric acid boiling. The analytical numbers are given upon which the above reactions are founded.

Dr. DEBUS said the reaction was interesting, as in the second equation the hydriodic acid first evolved reduced

* Le Conte's correction of Regnault's figures introduced here would make O = 15·9622 instead of 15·9633. Difference, 0·0011.

the sulphuric acid, hydric sulphide being formed. Under certain conditions hydric sulphide was obtained from the action of zinc upon sulphuric acid, the nascent hydrogen reducing the sulphuric acid. In both cases the sulphur changed its valency.

"*The Action of Nitrous Anhydride on Glycerin*," by O. MASSON. The author employed the pure glycerin of commerce, and generated the nitrous anhydride by the action of nitric acid, sp. gr. 1·35, on "porcelain arsenic." The gas was dried over fused calcium chloride, and then passed direct into the glycerin. The reaction takes place quietly; the glycerin greatly increases in bulk and mobility; its colour changes through yellow to brown, finally becoming dark green. Two layers of liquid form, an aqueous solution of nitrous acid and of oxidation-products of glycerin, and a layer which consists of the nitrous ether of glyceryl. These layers react upon each other, and should therefore be separated as soon as possible. By passing a rapid current of dry hydrogen, the author succeeded in distilling the ether at 100°, or 50° below its boiling-point. Analysis indicated the formula $C_3H_5(NO_2)_3$. The liquid was distilled several times; it is amber coloured, boils with decomposition at 150°, burns with a whitish flame, but does not explode under the hammer. It does not mix with water, but the ether is decomposed at the surface of contact. It cannot be preserved pure. When enclosed in sealed tubes it produces pressure enough to shatter the glass.

The Society then adjourned to June 21, when a ballot for the election of Fellows will be held, and a paper "On Distillation *in vacuo*" will be read by Prof. McLeod.

PHYSICAL SOCIETY.

Saturday, June 9th, 1883.

Prof. CLIFTON, President, in the Chair.

DR. OBACH described an improved construction of the movable coil galvanometer for determining currents and E.M.F. in absolute measure. This is a more sensitive, accurate, and powerful instrument to the old form. It is intended for accurate measurements and testing other instruments. The needle of the new form does not dip, and its vibrations are rendered dead-beat by an air-chamber. The secants of the inclination of the coil are the multipliers of the tangents of the deflections. The coil consists of a single solid rod or band of copper for measuring powerful currents; and on the same ring is a fine coil of German silver wire for measuring E.M.F. No shunt is required, owing to the movability of the coil. Dr. Oback gave figures showing the accuracy of the apparatus, which is very great.

Profs. AYRTON and PERRY read a paper on the "*Electric Resistance of Water*," being the results of some experiments made by them some time ago. A comparison of the galvanometer and electrometer methods of measuring this resistance was made during the experiments, the results being in favour of the latter, especially with currents of less than 6 volts. When the electrodes or platinum plates in the water were end-on, the resistance was less than when face to face.

Mr. BOYS thought this curious result might be due to the resistance between the surface of the plates and the water being reduced.

In answer to Dr. COFFIN,

Prof. AYRTON stated that the plates were heated between every two experiments in the blowpipe.

Prof. G. GUTHRIE remarked that Kohlrausch had found ordinary distilled water to be much more conductive than pure distilled water, which was an insulator, and enquired if Prof. Ayrton chose pure water.

The latter replied that his experiments were to test the merits of the galvanometer and electrometer modes of testing.

Prof. JONES stated that he found it best to use alternating currents for measuring the liquid resistance of cells, and described a mercury commutator for rapidly reversing the testing current.

Prof. AYRTON then described a lecture apparatus for showing the laws of centrifugal force. A rapidly rotated arm carrying a movable weight springs from the centre of an aneroid chamber filled with mercury. This chamber is on the rotating axle, and as the centrifugal force of the arm pulls out the diaphragm, the mercury falls in the chamber and in a tube opening from it.

Prof. GUTHRIE remarked that the apparatus would serve as a speed counter.

Prof. PERRY then read a paper on the "*Kinetic Energy of Rotating Bodies*," in which he pointed out the practical drawbacks to the "moment of inertia" calculations, and suggested the use of a new constant (termed for the nonce the "M"). This is the amount of kinetic energy possessed by a rotating body when making one revolution per minute. To find the energy for N revolutions per minute, multiply this by N_2. In the same way the "M" of a machine can be found and used.

NOTICES OF BOOKS.

Thirteenth Annual Report of the Deputy Master of the Mint, 1882. London: G. E. B. Eyre and W. Spottiswoode.

THE figures contained in this report of the Deputy Master of the Mint show in a highly interesting form all that relates to the production of the coinage of the realm for the past year; and, with the valuable statistics that are also given of the coinages of the principal European Mints, exhibit in a way that cannot fail to give rise to much thought the state of the field occupied by the precious metals as media of exchange.

Although for the year the ordinary business of the Mint has not been so great as usual, activity has been exhibited in other directions by the introduction of several important reforms in the reorganisation of the buildings and machinery, in order to keep the establisment abreast with the times. In the scientific department changes of considerable importance have been made, chief of which is the eviction, by the efforts of Prof. Roberts, of the very ancient and no less cumbersome practice that has existed for centuries of reporting the composition of gold bars in the "carat" system, in transactions with the Bank of England. As this unwieldy unit of weight has been allowed to exist so long in spite of the evidence afforded of the advantages possessed by the decimal system long since adopted in the Continental Mints, it may be of interest to give the following extract from Prof. Roberts's memorandum appended to the Report, showing the reasons that have led to the abolishment of this ancient practice.

The most important question which has received attention relates to the bullion transactions between the Mint and the Bank of England. The composition of gold ingots imported for coinage has hitherto been expressed by the "carat" system; but after careful consideration it has been determined to replace this method of reporting the results of assays by the decimal system already employed in the Australian Branches of the Mint and in foreign countries. The ancient method has survived from the earliest times of which there are Mint records, and is described in the accompanying official letter, suggesting that certain changes in the existing practice should be adopted.

20th July, 1882.

SIR,

I beg leave to submit the following statement as to the method now in use for reporting the results of assays on ingots of gold imported for coinage.

The essential facts are well known, and may be briefly set forth as follows :—

In assaying coin and the bars into which the metal imported for coinage is melted, the result of each assay is expressed decimally, fine gold being taken as the unit of comparison, or as 1000, and the standard prescribed by law for gold coin being 916·6. This system has long been adopted on the Continent and in the Australian Mints, but in this country, side by side with it, a much older one is employed in the Mint, and by jewellers and others. The latter system consists in recording the alloy as being so much "better" or "worse" than standard, and is founded on an ideal unit, the "Carat Pound," which is divided into 24 parts termed carats, British standard gold containing 22 carats of gold and 2 carats of alloy metal in every 24 parts. The carat is further sub-divided into four parts termed "carat grains," and the grain into eight parts, the smallest division of the carat scale being thus the $\frac{1}{4}$th of a carat grain, or the $\frac{1}{7\,6\,8}$th part of the carat pound. In order to attain a still greater degree of minuteness, the eighth part of a carat grain is further sub-divided into 7½ parts, or "excess grains." Each of these final divisions is thus the $\frac{1}{5\,7\,6\,0}$th part of the "carat pound," and, as the Troy pound also contains 5760 grains, each excess grain of gold beyound the last eighth in the assay report is reported as an "excess grain of gold on the Troy pound."

From the point of view of convenience or accuracy in recording the results of the operations of assaying, the carat system is not found to present any difficulty when the operator is familiar with its use. It should further be pointed out that the system is very convenient to those who are accustomed to conduct commercial transactions in the precious metal on the basis of the alloy known as standard gold; but it has the disadvantage of being unintelligible to those who employ the decimal system, and who are therefore in the habit of mentally referring to pure gold as 1000. It is even found wanting in clearness by many who are conversant with the ordinary operations of coinage or bullion transactions. For instance, the meaning of "Worse o 1½ + 1" as the assay report of an ingot is at least obscure, while the equivalent statement that the standard fineness of the ingot is 900 at once suggests that 1000 parts of the metal contain 900 parts of gold.

The retention in the Mint of the old system of carats and grains is probably due to the fact that simple tables for calculating the admixture of bullion with the copper required to form standard alloy have been in use at least since the latter part of the 17th century. A set of such tables was published in 1679, having been prepared many years before by Mr. John Reynolds, Assay Master in the reign of James I. From the Mint point of view any belief in the superior convenience of the system may be considered to be based rather upon long usage than upon its merits, and the officers who now conduct the "rating," that is the calculation involved in the conversion of ingots into standard metal, recognise the advantages of, and would gladly use, tables framed on the decimal system.

No suitable tables of this kind at present exist. In the Australian Mints the amount of "alloy" necessary to add to each set of ingots melted in a single crucible is calculated separately, a method of procedure which is out of the question in dealing with the larger transactions of the Mint in this country. A set of tables was published in 1872 by the Deputy Master of the Sydney Mint, but these only show a progressive increase of $\frac{5}{1\,0\,0\,0}$ths, instead of the $\frac{1}{1\,0\,0\,0}$th actually required. I am, however, satisfied that, although the calculation of the necessary tables would involve much labour, it would be possible, before coinage operations are resumed, to interpolate in Mr. Elouis's tables numbers to meet the case of the ingots usually imported for coinage, the fineness of which is comprised within comparatively narrow limits.

It is now admitted as a well-ascertained fact that, while an assay of gold is probably accurate to the $\frac{1}{1\,0\,0\,0}$th part, the errors are certainly comprised within the limits $\pm\frac{5}{1\,0\,0\,0\,0}$th part of the piece of metal submitted to assay, or within a range of $\frac{5}{1\,0\,0\,0}$ths. Formerly assays were only reported to the ¼th of a carat grain, or to the $\frac{1}{7\,6\,8}$th part. Later the Assayers to the Bank of England were instructed to give, in addition to the report expressed in carats and grains, a decimal report to the $\frac{1}{1\,0\,0\,0}$th part. In 1870, however, the Governors of the Bank of England directed that the decimal report expressed to the $\frac{1}{3\,0\,0\,0}$th (the third of a millième) should alone be given. So far as I am aware it was urged as a reason for this decision that the process of assaying did not admit of a higher degree of accuracy, and this view was based on the results of a series of assays made by different assayers on the same ingots of gold. The discrepancies in the results justified the views then adopted, but these discrepancies did not depend solely on the limits of accuracy which it is possible to attain in assaying, for, as was pointed out in the "Second Annual Report" (1871), p. 39, when widely divergent results are obtained the gold employed as a check by one or other assayer (in controlling the results afforded by the balance) is probably impure, while the supplementary trial plate made in 1873 constitutes a common standard of reference by which discrepancies might in future to a great extent be avoided. It may perhaps be pointed out that the $\frac{5}{1\,0\,0\,0}$th part is a more minute division than the "excess grain," which is nearly equivalent to $\frac{1}{1\,0\,0\,0}$th parts.

I would suggest, therefore, that the Mint should abandon the system of reporting assays of ingots in carats and grains, and adopt, as in the case of bars and coin, the decimal report expressed to the $\frac{5}{1\,0\,0\,0}$th part, and that the Governors of the Bank of England should be invited to instruct their Assayers to report to the $\frac{1}{1\,0\,0\,0}$th part, the practice of reporting to the ⅓rd of a millième being discontinued.—I have, &c.,

W. CHANDLER ROBERTS.

The Deputy Master of the Mint.

The ancient system of reporting the results of assays possesses many points of interest, and it may be well to add a few details respecting it, taken from a work by Snelling,* an authority on the computation of the value of bullion, who, writing in 1766, observes that "by the word SILVER we understand not only the metal so-called, pure and unmixed, but also when in a mass with copper; and if but one-half, two-thirds, or any other proportional part of it be silver, yet the whole bears that name. The same is to be understood of GOLD, when by itself or in a mass with silver and copper together, or with either of them alone.

"This is the reason that inquires are not made, what quantity of fine gold or fine silver is contained in any mixture, which seems to be the most natural inquiry, but how much standard it holds." Thus it is that "the Assay Master, in reporting the result of an assay, does not give the absolute fineness or the quantity of fine silver or fine gold present, but only the relative quantity or fineness, that is, how much the mixture is more or less than standard."

This is the system which has just been displaced in the Mint. Its cumbersome nature will be evident, but it should be pointed out in its defence that, as Snelling proceeds to remark, "the quantity of 'betterness' or 'worseness' in an ingot being added to or subtracted from the weight of it, gives the quantity of standard metal contained in it," and that therefore the "betterness" or "worseness" affords a ready means of determining the amount of copper or gold required to standardise the whole. Further, if a number of ingots of varying weights and fineness have to be dealt with, a similar result will be arrived at by taking the algebraical sum of the several products of their weights and "betterness" or "worseness." These advantages, however, apply to individual

* "Doctrine of Gold and Silver Computations," by Thomas Snelling, London, 1766.

calculations, and become unimportant when standarding tables adapted to the decimal system are available. Such tables have been provided during the past year.

*** Since the above was written, gold of the value of over £2,000,000 has been imported for coinage, and the convenience and accuracy of the system advocated above has been abundantly demonstrated.

From the same Memorandum we take the following extract, which is of historical as well as scientific interest, relating to the accurate estimation of silver by the "wet" and "dry" methods:—

METHOD OF ASSAYING SILVER.

Since 1871 the volumetrical method devised by Gay-Lussac has been used for verifying the composition of bars and coin. It only claims to be a means of verifying the standard of an alloy, and consequently it cannot be applied to alloys the composition of which is not approximately known. It is true that this objection does not apply to the ordinary practice of the Mint, as 'trade assay reports' are furnished either with the ingots or with so little delay that no inconvenience need ensue. The reasons which led to the adoption of the "wet" or verification method in France formed the subject of an elaborate series of papers communicated by M. Thiers to the British Government in 1836.* I have so frequently alluded to its advantages that it may be well to explain why the assay by cupellation was retained in re-organising the Assay Department.

The Commissioners appointed in France in 1829, to investigate the methods of assay then in use, sent alloys of silver and copper, the standards of which were accurately known, to the Assayers of the principal European Mints, including the Mint in this country. The reports of all these Assayers indicated the presence of less silver than the alloys actually contained, the deficiencies varying from 0·2 to 1·0 per cent. The evidence gathered by the Commissioners led them to recommend the adoption of Gay-Lussac's method, and the authority of the Commission, of which the well-known chemists Thénard, Dulong, and Gay-Lussac, were members, discredited the "dry" process on the Continent, and led to its being employed only for obtaining an approximate assay. In this country, on the other hand, the method was retained, carefully devised furnaces and appliances were adopted, and the results of the assays were controlled by an elaborate system of "check assays" on standards of known composition. It is unquestionable that the process has been conducted for centuries in this country with great skill by successive Assayers of the Mint, and, in later years at least, has yielded results which are not merely trustworthy but deserve the highest confidence.

I was anxious that this process, which may be considered to be historical, should be retained for its own sake quite apart from the necessity of employing it whenever the composition of the alloy is not approximately known. The traditional skill in conducting the dry process has, I am satisfied, been well sustained, and all the ingots imported for coinage during the past year have been assayed by its means. Since the close of the year, however, 1097 verification assays of ingots have been conducted by the wet process, and in future either process will be used as special circumstances may require.

Oil of Angelica from the Roots.—Laurent Naudin.—The author concludes that the two terpenes boiling at 158° and at 171° to 175° respectively, mentioned by Beilstein and Wiegand, are merely mixtures of the polymers of the carbide boiling at 166°, modified by the action of sodium and by prolonged ebullition.—*Moniteur Scientifique.*

* "Report of Select Committee of the House of Commons on the Mint," 1837, Appendix, p. 96.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
May, 1883.

Part Played by Microbia in Pathology.—M. Boulet.—A purely medical dissertation.

Saccharine Urines.—L. Legrip.—A treatise on the qualitative detection and the quantitative determination of glucose in diabetic urines. As qualitative reagents, he describes bismuth sub-nitrate, caustic alkalies, Trommer's test, sodium sulphindigotate, ammoniacal silver nitrate, and ferric hydroxide. He also mentions the fermentation process, and the separation of sugar in a crystalline form, which is not in all cases practicable. Among quantitative procedures, he condemns the fermentation method. He gives several modifications of Fehling's method, as also those of Millon and Commaille, and of Sachsse.

Law of the Congelation of Aqueous Solutions of Organic Matters.—F. M. Raoult.—It has been previously shown by Blagden and Rüdorff that the freezing-point of a liquid is lowered proportionately to the weight of one and the same salt dissolved in a constant weight of water. M. de Coppet has further shown that the specific lowerings of the congelation-point of certain salts are almost inversely proportional to the respective molecular weights of these salts. M. Raoult has extended these observations to organic substances. He finds that the lowering of the congelation-point is proportional to the weight of the substance dissolved in the water, provided that the lowering does not exceed 2°. If the lowering of the congelation-point, referred to 1 grm. of the substance dissolved in 100 grms. of water, is multiplied by the molecular weights of the substance, the result is approximately constant.

Cause of the Colour of Precious Stones.—Col. W. A. Ross.—From the *Proceedings of the Royal Society.*

The Properties of Pure Metallic Aluminium.—J. Mallet.—From the CHEMICAL NEWS.

Contribution to the Study of the Tungsten Compounds.—G. von Knorre.

Notice on Barium Hydroxide on the Haloid Salts of Barium and on Basic Barium Chloride, Bromide, and Iodide.—E. Beckman.—From the *Journal für Praktische Chemie.*

Electrolytic Separation of Metals.—From the CHEMICAL NEWS.

New Method of Manufacturing Sodium Sulphide.—W. Weldon.—From the *Journal of the Society of Chemical Industry.*

Utilisation of Nitrogen Compounds lost in the Manufacture of Sulphuric Acid.—J. Wachtel.—The author proposes to aspirate the gases through a cast-iron retort, filled with iron turnings, and heated to redness. The hydrogen liberated by the reaction of watery vapour reduces the oxides of nitrogen, forming ammonia, which is then absorbed in sulphuric or hydrochloric acid.

Density of Monohydrated Sulphuric Acid.—A. Schertel.—From the *Journal für Praktische Chemie.*

Use of Dehydrated Oxalic Acid for Preparing Normal Acidimetric Liquids and Standard Permanganic Solutions.—Professor W. Hampe.

Detection of the Eosine Colours.—Rudolf Benedikt.—Already inserted.

Extraction of Cellulose from Wood.—R. Mitscherlich.—The author treats the wood, &c., suitably comminuted, with calcium sulphite under pressure. The

cellulose is then separated from the soluble matters by means of a filter-press, and after washing is fit for paper-making.

Composition of the Water which escapes from the Petroleum Wells of the Caucasus.—A. Potilizin.—The waters in question are remarkably rich in sodium iodide and bromide.

Dephosphorisation Slags used as Manure.—The slags contain as much as 19 per cent phosphoric acid. They should be used simply ground, rather than rendered soluble by means of sulphuric acid.

Mineral Colours with Tungstic Acid.—By the double decomposition of a soluble tungstate with metallic salts there are obtained coloured precipitates capable of being used as pigments. Nickel tungstate is a light green, chrome tungstate a deep green, cobalt tungstate a violet or indigo blue, barium tungstate a fine white body colour, and free tungstic acid a light brilliant greenish yellow.

History of China cuprea.—O. Hess.—This memoir is mainly of pharmacological interest.

Researches on Gelsemine.—S. W. Gerrard, F.C.S.

Physiological Action of Gelsemine.—Dr. G. Rauch.

Action upon the Eye.—Prof. J. Tweedy, F.R.C.S.—These three papers appear to be from an English source.

The Preparation of Quinoleine.—R. Bourcart.—The process given is a modification of that of Skraup.

New Electric Apparatus for Preventing Boiler Explosions.—The apparatus, which is not described, registers automatically the level of the water in the boiler.

Incombustible Paper, Ink, and Colours.—The paper consists of asbestos; the inks and colours are made of coloured earths, such as umber, Sienna, &c., ground up with glycerin and solutions of soluble silicates.

Certain Azo-Derivatives.—Ch. Girard and A. Pabst.—The diazo-derivative of sulphanilic acid yields yellows with dimethylaniline, resorcine, and α-naphthol, and oranges with β-naphthol and diphenylamine. Methyl-resorcine gives likewise a yellow-orange. On combining diazo-phenyl-sulphurous acid with pyro-gallol-sulphurous acid, there is obtained a deep orange, somewhat fugitive, transparent, and which does not cover the fibre well. Cresylol gives in the same manner an orange. With methyl-diphenylamine we have a fine deep orange, differing little from that derived from diphenylamine; methyl-dixylidine gives an orange-scarlet, and methyl-dinaphthyl-amine an orange-red. Naphthylamine sulphurous acid furnishes, in the same manner, a diazo-derivative, which, with methyl-diphenylamine produces a scarlet-red. Analogous shades are obtained with benzyl-diphenyl-amine, dixylidine, methyl-dixylidine, dinaphthylamine, cresyl-naphthylamine, methyl-dinaphthylamine, ethyl-dicresylamine (liquid or solid), and amyl-diphenylamine. These shades vary from scarlet to crimson. Diazo-dinitro-phenol obtained from picramic acid gives, with resorcine, a garnet-ret, passing quickly to a maroon, and probably undergoing decomposition; the ammoniacal solution is a garnet-red, and dyes fibres a reddish maroon. With methyl-resorcine we have a fine garnet-red, and with the sulpho-conjugated compound of dimethyl-resorcine a reddish brown. Phenol gives a dirty orange-brown; methyl-naphthol, a violet; amido-azo-naphthaline, an intense brown; and gallic acid, a fine yellow-brown. Cœruleine combines with difficulty, giving a dirty green, and eosine a fine brown. Sodium alizarine sulphite gives a green-brown, slightly dichroic; rosaniline sulphite, a garnet-brown, also dichroic; and anthraquinone sulphite, a green-brown, verging upon an olive. Phthalic acid and phthalimide give a dull, transparent, yellowish brown. Methyl-diphenylamine produces in alkaline solutions an orange-brown, but, in presence of acetic acid, a bronze-brown. With oximido-naphthol the authors have obtained a very fine brown. Picric and picramic acid yield oranges which are brownish, dirty, and transparent. The azo-compounds have the less colouring-power the more symmetrical is their molecule. The introduction of a sulpho-conjugated group turns their shade to a yellow-orange, whilst additions of methyl in a phenolic or amidic function modifies the shade slightly towards a red.

Journal für Praktische Chemie.
New Series, Vol. xxvii., Nos. 4 and 5, 1883.

Saturation-Capacity of the Elements, especially of Sulphur.—C. W. Blomstrand.—This important paper is unfortunately too long for reproduction.

Ethylene Ethers of the Nitro-phenols and of the Oxybenzoic Acids.—Dr. Edmund Wagner.—We find here an account of ethylen-dinitro-phenyl-ether, ethylen-diortho-amido-phenyl-ether, ethylen-diortho-amido-phenyl-ether hydrochlorate, diacetyl-ethylen-diortho-amido-phenyl-ether, ethylen-dipara-amido-phenyl-ether and its salts, ethylen-dimeta-amido-phenyl-ether, ethylen-phenol-para-oxybenzoic acid, ethylen-nitro-phenol-oxybenzoic acids, their ethers and salts.

Chemical Dialysis with the Application of Chloroform, Water, or Ether, and its Significance for the Analysis of Vegetable and Animal Albumenoids.—H. Struve.—The author ascribes the imperfect success which has attended dialytic researches on the albumenoids to three causes,—the instability of the substances, the use of parchment paper, and the difficulty of examining the substances which pass through the dialyser. To meet the first difficulty, of which all experimentalists have been aware, the operation has always been carried out at the lowest practicable temperature, as quickly as possible, and with frequent renewal both of the external liquid and of the parchment paper. Everyone who has undertaken dialytic experiments knows the difficulty of meeting with a good parchment paper of uniform quality. The author considers that the distinction between colloid and crystalloid substances, as proposed by Graham, cannot be maintained. For the membrane he selects the bladders of animals. He softens them in water, frees them mechanically from fat as completely as possible, and then treats them repeatedly with ether. Bladders thus prepared and submerged in ether retain their good qualities for years. For the external fluid he recommends water which has been shaken up with an excess of chloroform, and allowed to separate on standing. It prevents, or at least retards, chemical changes in the substances operated upon.

Studies on Milk.—H. Struve.—The author comes to the conclusions that human milk and cows' milk contain the identical albumenoids. Human milk contains, however, a smaller proportion of albumenoids, and especially of caseine. All the albumenoids held in solution in milk can be separated by dialysis (with chloroform water) from the undissolved caseine and from the butter. A part of the undissolved caseine forms the covers of the milk-globules, and is separated out in the cream; the other portion remains in the skim-milk. The milk-globules swell up if shaken with ether. The digestibility of any milk is inversely as the quantity of caseine which remains in the skim-milk. Hence Dr. Biedent's suggestion that only cream should be used for the earliest nourishment of young children brought up by hand is perfectly justified. The caseine of human milk, as well as of cows' milk, has always an acid reaction. In human milk there is only a small quantity of butter in a free state.

Journal de Pharmacie et de Chimie.
Tome vii., May, 1883.

Chemical Study of the Globulariæ.—MM. Heckel and Schlagdenhauffen.—This paper has more of a pharmaceutical than of a strictly chemical character.

Specimen of Cinchona succirubra Grown in the Conservatories of the Faculty of Medicine.—MM. J. Regnault and Villejean.—The authors admit that the facts mentioned in their paper are not of great interest.

Alumed Wines.—P. Carles.—It appears that alum is sometimes added to wines to give astringency and to raise the colour. For its detection it is necessary to evaporate to dryness and destroy the organic matter by ignition.

The Ptomaines before the Tribunals.—L. Garnier.—The author points out as a characteristic symptom produced by the ptomaines the loss of cutaneous sensibility and of muscular contractility, even under electric excitement, which are produced by no vegetable poison except muscarine. The reduction of potassium ferricyanide is characteristic only in the absence of morphine, apomorphine, veratrine, hyoscyamine, and muscarine. Their physical form is in most cases amorphous or indistinctly crystalline. Their separation from the true alkaloids is a matter of extreme difficulty if the analysis is not undertaken immediately after death. In spite of the use of the successive solvents indicated by Dragendorff, and the ultimate transformation of the extracts into crystalline salts, we always obtain alkaloids more or less mixed with ptomaines, and giving the reaction with ferricyanides. Hence it is necessary to determine all the characters of the body isolated, and to compare the results obtained with the known reactions of the substance which we suppose we have in view.

Researches on the Passage of Alcoholic Liquids through Porous Bodies.—H. Gal.—Already noticed.

Comparison between Different Kinds of Gluten Bread.—A. S. Mallat.—A determination of the proportion of starch in various breads recommended for diabetic patients.

Analysis of a Verdigris sophisticated with Blue Sand.—M. Astre.—The specimen contained 10 per cent of sand coloured blue by means of Prussian blue.

Spontaneous Destruction of Oxalic Acid.—G. Fleury.—Standard solutions of oxalic acid containing 4 to 6 decigrms. per litre ceased to present an acid reaction. Large flocks of a cryptogamous vegetation had been developed similar to those which appear in solutions of tartaric acid. No similar change took place, even in four years, in standard solutions containing 6·3 grms. oxalic acid per litre. The bottles containing the weak solutions had been unstoppered only once or twice.

Detection and Determination of Benzoic Acid in Milk.—M. Meissl.—The author takes 250 to 500 c.c. of the milk, renders it alkaline with a few drops of lime, or baryta-water, evaporates down to one-fourth, adds calcium sulphate, and dries on the water-bath. He then adds more calcium sulphate and a few drops of baryta-water, pulverises finely, mixes it with dilute sulphuric acid, and stirs up in double its volume of alcohol at 50 per cent, which dissolves benzoic acid whilst taking up only the very slightest traces of fats. The liquid thus obtained,—which, besides the benzoic acid, contains milk-sugar and inorganic salts—is neutralised with baryta-water, and evaporated down to a small bulk. It is acidified with dilute sulphuric acid, and shaken up with a small quantity of ether, which on evaporation leaves pure benzoic acid. To effect the quantitative determination the residue is dried at 60°, weighed: the benzoic acid is driven off. On weighing again the benzoic acid is found as loss.

Researches on the Presence of Formic and Acetic Acids in Plants, and on the Physiological Part Played by these Bodies.—E. Bergmann.—These acids occur in the protoplasm of all the plants examined. They are found both in the colourless cells and in the green tissues, and must be considered as constant products of the transformation of the proximate principles. It is probable that several other acids of the fatty series, such as the propionic, butyric, capric, &c., are equally diffused in the vegetable kingdom. The quantity of the volatile acids increases in plants grown in darkness, whence they are products of regressive metamorphosis.

Preservative Action of the Vapours of Ether and Chloroform upon Organised Substances.—R. Dubois.—Of interest to the anatomist.

Presence of Copper in Cereals, Flour, Bread, &c.—M. Galippe.—Copper exists normally, in larger or smaller proportion, in plants, and especially in wheat. It exists in bread without having been fraudulently introduced.

Some New Metallic Derivatives of Taurine.—M. Guerin.—The author describes taurine cupro-ammonium, taurine zinc-ammonium, and taurine sodium chloroplatinate.

Researches on the Hyponitrites.—MM. Berthelot and Ogier.—From the *Comptes Rendus*.

Bulletin de la Société Chimique de Paris.
No. 10, May 20, 1883.

The Double Orthophosphates of Barium and Potassium and of Barium and Sodium.—A. de Schulten.—The author obtains the former of these compounds by mixing a solution of potassium silicate with baryta-water, heating it to a boil, and then adding a solution of potassium silicate containing in solution potassium phosphate. The sodium compound is obtained in an analogous manner. The quantities of phosphate and of baryta-water must be small in proportion to the silicate.

On Certain Properties of Normal Camphor Monochloride.—P. Cazeneuve.—The author studies here the behaviour of the camphor compound with hydrogen, soda-lime and quicklime, alcoholic potassa, and sulphuric acid.

Action of Fuming Nitric Acid upon Camphor Monochloride.—P. Cazeneuve.—On causing four parts of hot fuming nitric acid to act upon one part of the camphor compound, the author obtains, among oxidation and destruction products, a chloro-nitro compound answering to the formula $C_{10}H_{14}Cl(NO_2)O$, essentially analogous to the bromo-nitric compound of R. Schiff.

Russian Chemical Society, Session of September 16th/28th, 1882.

M. Mestchersky sent a memoir on the salts of bismuthic acid. He has not succeeded in obtaining barium bismuthates of constant composition.

MM. Lidoff and Tischomiroff have continued their researches on the action of the electric current upon the chlorates. On employing carbons as electrodes the authors find that the decomposition of the alkaline chlorides is not complete, and is always accompanied by a decrease of the weight of the positive carbon. On the other hand, on causing the current to act upon a chlorate, the weight of the carbon diminishes immediately, the chlorate being converted into chloride. When using a positive pole of platinum the authors find that the chlorate is decomposed into a chloride and ozone.

M. Lidoff gave in a memoir on the coke of petroleum. It is purer and harder than that of coal, more compact, and burns with more difficulty. For the electric light and for the manufacture of electrodes it is superior to ordinary coke.

M. Potilitzine sent in a memoir on the composition of petroleum, and of those which are ejected by the mud-volcanoes of the Caucasus.

M. Dianine finds that the oxidation of phenol by permanganic acid gives rise to a phenol identical with that obtained by Engelhardt and Latchinoff.

M. Grigorieff sent in an analysis of certain springs at Moscow, and an account of certain new deposits of a mineral manure.

M. Menschutkine described his researches on the decomposition of tertiary amyle acetate by heat.

MEETINGS FOR THE WEEK.

WEDNESDAY, 20th.—Meteorogical, 7.
— Geological, 8.
THURSDAY, 21st.—Royal, 4.30.
— Royal Society Club, 6.30. (Anniversary.)
— Chemical, 8. Ballot for the election of Fellows. "On Evaporation *in vacuo*," by Prof. H. McLeod. "Note on Hydrocarbons from Camphor," and "Note on some Substitution Derivatives of Camphor," by H. E. Armstrong. "On the Decomposition of Ammonium Nitrate; an Investigation into the Rate of Chemical Change," by V. H. Veley.
FRIDAY, 22nd.—Quekett Club, 8.
SATURDAY, 23rd.—Physical, 3. "Researches upon the cause of Evident Magnetism and Neutrality in Iron and Steel, Illustrated by Experiments," Prof. Hughes. "A Sine Electrometer," by Prof. G. W. Minchin. "Induction Balance Effect and Densities of Alloys of Copper and Antimony," by Mr. G. Kamensky.

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Wanted, Assistant Chemist: one accustomed to Sugar, Glucose, and Starch Products preferred.—Apply J. T. Armstrong, Victoria House, Newcastle, Staffordshire.

Wanted, Chemist acquainted with manufacturing by the ammonia-soda process; knowledge of engineering desired; no subsisting agreements on the part of the applicants need stand in the way; salaries large.—Communications strictly confidential, to S., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

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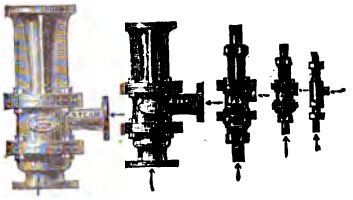

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1230.

ON THE DETECTION OF UREA IN AN AQUEOUS SOLUTION.

By C. L. BLOXAM.

A WEAK solution of urea or its nitrate in water presents a difficult problem to the analyst. I have found the following methods very useful in solving it:—

Cyanuric Acid Test.—Ascertain, by testing for nitric acid, whether the nitrate is to be suspected; if so, mix the solution with a few drops of solution of NH_4Cl; but if no nitric acid be found, acidify the solution with HCl. Evaporate the solution on a porcelain crucible lid, or on a glass slide, and heat the residue as long as it continues to evolve *thick* white fumes. Dissolve the cooled residue in a drop or two of NH_3, add a drop of $BaCl_2$, and stir with a glass rod. If urea had been present, a crystalline precipitate of barium cyanurate will be formed on the lines of friction made by the rod upon the glass slide.

A very characteristic test for the cyanuric acid consists in dissolving it in a drop or two of ammonia, and adding a drop of a weak solution of cupric sulphate. On standing for a few minutes, a violet coloured crystalline precipitate separates. If the experiment be made on a crucible lid, this precipitate collects in the angle of the lid, when the latter rests obliquely on the table, and a very small quantity becomes perceptible. The precipitate appears to be the cyanurate of cuprammonium described by Wöhler, and is seen under the microscope to consist of very definite rhomboidal plates of a fine red-violet colour.

King's College, London, June 15, 1883.

ON A NEW METHOD FOR THE ESTIMATION OF MINUTE QUANTITIES OF CARBON, AND A NEW FORM OF CHROMOMETER.*

By J. E. STEAD, Middlesborough.

PART I.—ESTIMATION OF MINUTE QUANTITIES OF CARBON.

As is well known, it is impossible to determine with accuracy minute quantities of carbon by the ordinary colour method, owing to the colour of the nitrate of iron present, which interferes so as to make it impossible to judge of the colour due to carbon.

Having been engaged in some careful investigations on the nature of the colouring matter which is produced by the action of dilute nitric acid upon white iron and steel, it was found it had the property of being soluble in potash and soda solutions, and that the alkaline solution had about two and a half times the depth of colour possessed by the acid solution. This being so, it was clear that the colour matter might readily be separated from the iron, and be obtained in an alkaline solution, by simply adding an excess of sodium hydrate to the nitric acid solution of iron, and that the colour solution thus obtained might be used as a means of determining the amount of carbon present. Upon trial this was found to be the case, and that as small a quantity as 0·03 per cent carbon could be readily determined.

The method as now in use is conducted as follows:—

Standard solution of nitric acid, 1·20 sp. gr.
Standard solution of sodium hydrate, 1·27 sp. gr.

One gramme of the steel or iron to be tested is weighed off and placed in a 200 c.c. beaker, and, after covering with a watch-glass, 12 c.c. of standard nitric acid are added. The beaker and contents are then placed on a warm plate, heated to about 90° to 100° C., and there allowed to remain until dissolved, which does not usually take more than ten minutes. At the same time a standard iron containing a known quantity of carbon is treated in exactly the same way, and when both are dissolved 30 c.c. of hot water are added to each, and 13 c.c. soda solution.

The contents are now to be well shaken, and then poured into a glass measuring-jar and diluted till they occupy a bulk of 60 c.c. After again well mixing and allowing to stand for ten minutes in a warm place, they are filtered through dry filters, and the filtrates, only a portion of which is used, are compared. This may be done by pouring the two liquids into two separate measuring-tubes in such quantity or proportion that upon looking down the tubes the colours appear to be equal.

Thus if 50 m.m. of the standard solution is poured into one tube, and if the steel to be tested contains say half as much as the standard, there will be 100 m.m. of its colour solution required to give the same tint. The carbon is therefore inversely proportional to the bulk compared with the standard, and in the above assumed case, if the standard steel contained 0·05 per cent carbon, the following simple equation would give the carbon in the sample tested:—

$$\frac{0{\cdot}05 \times 50}{100} = 0{\cdot}025 \text{ per cent.}$$

Experiments were made upon a steel which contained 0·11 per cent carbon to ascertain what the influence would be of heating the nitric acid solution for an increasing length of time after dissolving on the bath.

For this purpose five separate portions of the steel were weighed off, and each treated with 12 c.c. nitric acid. The iron in all was completely dissolved in five minutes. One portion was at once taken off and treated with water and soda. A second portion was allowed to remain ten minutes on the bath, a third fifteen minutes, a fourth twenty minutes, and the last twenty-five minutes. Each portion when removed from the bath was treated as before described, and when all the clear colour solutions were obtained they were carefully compared, with the following results:—

Carbon—				
5 minutes.	10 minutes.	15 minutes.	20 minutes.	25 minutes.
0·098 p.c.	0·110 p.c.	0·110 p.c.	0·110 p.c.	0·108 p.c.

From this it will be seen that the carbon colour is not materially affected by heating the acid solution twice as long as is necessary for completely dissolving the carbon compound, and that, although the iron is dissolved in five minutes, it is evident that some of the carbon compound at first formed escapes solution in that period.

The next point was to ascertain what effect the use of an excess of nitric acid in dissolving the steel would have on the colour matter.

To determine this, five separate portions were treated respectively with 12, 15, 18, 21, and 25 c.c. of nitric acid, and heated for ten minutes on the bath; after which they were all treated with water and an excess of soda solution, and, after filtering, the clear filtrates were compared, with the following results:—

Carbon—				
12 c.c.	15 c.c.	18 c.c.	21 c.c.	25 c.c.
0·41 p.c.	0·41 p.c.	0·41 p.c.	0·402 p.c.	0·380 p.c.

From which it is seen that 6 c.c. acid in excess does not materially affect the determination, but when this is exceeded the colour is reduced in quantity.

It now became important to know if a greater or less

* A Paper read before the Iron and Steel Institute.

quantity of soda solution would have a different solvent power on the colouring matter.

To ascertain this, four separate portions of the soft steel were treated alike in dissolving, but to the solutions different quantities of soda solution were added.

The following results were obtained, viz.—

Sodium Hydrate.

	13 c.c.	15 c.c.	18 c.c.	21 c.c.
Carbon ..	0·110 p. c.	0·110 p. c.	0·110 p. c.	0·115 p.c.

Here it will be seen that, as before stated, 13 c.c. sodium hydrate solution is capable of effecting solution of the colouring matter. By using a less amount, however, by experiment it was found that the colour is precipitated with the iron oxide.

It is very well known that in the old acid colour method very slight traces of hydrochloric acid, if present, alter the character of the colour to such an extent as to make the colour determination unreliable. It therefore was of interest to ascertain if the same would occur in the alkaline method. Four portions of steel were treated as usual, excepting that to one portion a single drop of hydrochloric acid was added when being dissolved, to a second five drops, and to a third ten drops, but to the last portion no hydrochloric acid was added.

The following are the results obtained, viz.—

Hydrochloric Acid.

	1 drop.	5 drops.	10 drops.	None.
Carbon ..	0·105 p. c.	0·090 p. c.	0·078 p. c.	0·110 p. c.

Second Test.

	1 drop.	5 drops.	10 drops.	None.
Carbon ..	0·356 p. c.	0·338 p. c.	0·324 p. c.	0·410 p. c.

The colour in each case, and even in that in which the larger quantity of hydrochloric acid was added, was the same in quality, although differing in quantity, showing (1) that the presence of chlorides is harmless, and (2) that nitro-hydrochloric acid, even in small quantities, prevents the formation of the full amount of colour matter capable of being produced by nitric acid alone.

A large number of samples of low carbon iron have been examined by the alkaline method, including samples of iron taken from the Bessemer converter at the end of the blow before any addition of spiegeleisen. The results are likely to be of interest to many members present, and I therefore give them here :—

Blown Iron taken from the Bessemer Converter.

No. 1	0·040 p. c. carbon.
No. 2	0·036 ,,
No. 3	0·045 ,,
No. 4	0·039 ,,
No. 5	0·061 ,,
No. 6	0·048 ,,
Average	0·045 ,,
Average by combustion	0·048 ,,

	New Colour Method.	Combustion.
Standard soft steel ..	0·120 p. c. carbon.	0·122 p. c.
Pure iron wire	0·038 ,,	—
Cleveland iron ship plates	0·055 ,,	—
Ditto ditto ..	0·035 ,,	—

The colour solutions from these low carbon irons are different in tint from those obtained from the higher carbon steels, and it is important that a low carbon iron be used as a standard for comparison.

When high carbon steel is heated to redness and chilled, it is well known that the colour from the chilled steel is very much less in quantity than that from the same steel before hardening. The difference, however, is not nearly so marked when there is little carbon present in the steel, as was proved by the following results, viz.:—

Several samples of iron and steel after being drilled were heated to redness and chilled in water, the results before and after being as follows :—

		Difference.
Soft steel = soft	0·168 p c.	
,, chilled in cold water ..	0·158 ,,	0·010 p.c.
,, chilled in hot water ..	0·168 ,,	
Staffordshire square iron bar..	0·110 ,,	
,, ,, ,, chilled	0·100 ,,	0·010 ,,
,, flat ,, ..	0·069 ,,	
,, ,, ,, chilled	0·069 ,,	None.
Soft steel	0·077 ,,	
,, chilled	0·071 ,,	0·006 ,,

It is not often that soft iron or steel is chilled before being placed in the hands of the analyst, but it is satisfactory to know that even if they were, the results by colour would not be rendered useless.

When using the new method, I have found that some steels give a much yellower colour than others, and in course of investigation have discovered that there are present in all nitric acid steel solutions two distinct colouring-matters, which I have separated and obtained in a nearly pure state, one of which is bright yellow, resembling potassium chromate, the other being of a dark brown-red colour. In some steel solutions the yellow colour preponderates, and in others the brown.

I expect and hope that the investigations I am working at will eventually throw some light on the true constitution of hard and soft steel, and I trust also that before long I may have the pleasure of bringing their results before you.

Part II.—A New Form of Chromometer.

In comparing colour solutions there are two methods of procedure. The first is that generally adopted in making determinations of the carbon by the acid colour process, in which the darker solution is diluted with water until the colours of the two solutions are equal in density—that is to say, until the colour is equal per cubic centimetre. The diluted volume is then noted, and the amount of carbon read off in 0·1 per cent per c.c. In the alkaline method it is better to use the second method, already described in this paper, of comparing directly the relative density of the colour solution without dilution, and ascertaining the lengths of the two columns of liquids, which, when examined from the surface, give the same depth of colour. The carbon in this process is, as compared with the standard, inversely proportional to the length of the liquid column.

If a fixed length of liquid column be used of the solutions of carbon and a variable standard column, then, by using a suitable standard solution, the carbon may be deduced from the length of the latter required to make a colour column equal in depth to the former and the percentage read directly from a graduated scale. The instrument I have arranged is made on this principle; it is extremely simple and easily constructed. It consists of two parallel tubes, which may be of any suitable diameter, one of which is contracted at a point 9 inches from the top, and is open at both ends. The lower end passes through an india-rubber cork to the bottom of a 4-oz. bottle, which contains the standard colour solution. A second tube of smaller diameter also passes through the cork into the bottle, the outside end of which is in communication with a large syringe.

Just above the contracted part of the first-mentioned tube a small glazed cylinder of china clay rests. By pressing the syringe the liquid can be forced from the bottle below up this tube. The second tube is about 9 inches long, and is closed at the lower end. At this end a small glazed clay cylinder is also placed. When this tube is placed parallel to the first, the length from the open upper ends to the flat surfaces of the clay prisms

is equal in each. A small looking-glass at an angle of 45° is fixed above the open ends of the tubes, and the standard tube is graduated into 0·01 part to 0·15 part.

The method of working with the apparatus is very simple. The colour solution to be compared is placed in the second tube, with which it is filled up to a certain fixed mark.

It is only now necessary to squeeze the syringe and force the liquid up the first tube until the colours in the two columns are equal, as can be seen by looking into the mirror above. The height of the standard solution is read off on the graduated scale, which will be the percentage of carbon in the steel or iron under examination.

THE ANALYSIS OF ENSILAGE MADE FROM A POOR QUALITY OF GRASS.

By FRANCIS SUTTON, F.I.C., F.C.S.

A CONSIDERABLE number of analyses of ensilages made from maize, rye, Italian rye grass, &c., have been published, but I am not aware that up to the present any experiments, either practical or chemical, have been made on common mixed grass such as is here examined. The hay No. 1 and its corresponding ensilage were made from grass growing naturally in a wood from which the trees had been partially cleared. Some years ago no seed of any kind was ever sown: previous to 1882 the grass was given away to anyone who would take the trouble to cut it for litter, the quality being very coarse and rank.

The hay No. 2, with its corresponding ensilage, were made from common mixed grasses growing in a rough meadow, and naturally of a poor, coarse description, though certainly better than No. 1. At the same time, it had no pretension to the quality of grass such as is necessary for the production of fine meadow hay.

I am indebted to Lord Walsingham, of Merton Park, Norfolk, for the opportunity of examining these samples of hay and ensilage; but the real work of designing and carrying out the ensilaging process, and the subsequent feeding experiments, is due to Mr. Henry Woods, his lordship's agent,—a gentleman who has made his name known throughout the world as a most active and intelligent agriculturist.

The chemical examinations were made with the utmost care, and in all important points were checked by duplicate estimations. The processes generally used for the examination of vegetable products of this description are no doubt familiar to most chemists, and therefore need no detailed description. It is necessary, however, to say that in the case of the ensilages no actual sugar occurs in the aqueous extract. Digestion with acid for some hours produces a substance which readily affects the copper reaction, but I have not yet been able to determine the nature of the sugar so produced. The hay made from the same grasses does yield a trace of ready-formed sugar, and this again is considerably increased by digestion with acid. Fine quality of hay, as is well known, contains a large proportion of sugar. I am inclined to think that ensilages from almost all fodder plants, if cut at the proper stage and well stored, are destitute of ready-formed sugar.

Report on the Analyses of Hay and Ensilage.

The two samples of hay consisted of a variety of grasses, many of them of a coarse description and of poor quality, and were destitute of the sweet smell and taste which always accompanies well-made meadow hay of good quality.

The texture of No. 2 was, however, preferable to No. 1, and the grass of a somewhat finer description.

Both specimens of ensilage were, on the contrary, highly odoriferous from the development of the essential oils peculiar to the various grasses, and had also a vinous smell, accompanied with a slight but pleasant acidity.

The smell of essential oils was so persistent that after handling the ensilage for some time it became very difficult to remove the smell by washing. On distilling some

Analysis of Two Samples of Hay and Two Samples of Ensilage.

GENERAL COMPOSITION.

	Natural State.				Dried at 212° Fahr.			
	Hay. No. 1.	Hay. No. 2.	Ensilage. No. 1.	Ensilage. No. 2.	Hay. No. 1.	Hay. No. 2.	Ensilage. No. 1.	Ensilage. No. 2.
Water	22·20	24·90	74·30	65·95				
Soluble organic matter	8·21	9·75	6·24	9·17	10·55	13·00	24·28	27·00
Soluble inorganic matter	4·05	3·15	1·78	1·88	5·20	4·20	6·92	5·55
Insoluble organic matter	61·04	58·50	16·91	22·18	78·50	77·85	65·80	65·05
Insoluble mineral matter	4·50	3·70	0·77	0·82	5·75	4·95	3·00	2·40
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

DETAILED COMPOSITION.

	Natural State.				Dried at 212° Fahr.			
Water	22·20	24 90	74·30	65·95				
Albumen and protein substances, soluble in water*	0·73	0·88	1·60	2·12	0·94	1·17	6·22	6·23
Insoluble protein compounds**	5·03	7·09	1·41	1·43	6·46	9·45	5·49	4·20
Sugar, gum, and extractive matter, soluble in water	7·48	8·87	4·64	7·05	9·61	11·85	18·06	20·73
Oil, wax, chlorophyll, &c.	1·29	1·34	0·72	0·89	1·54	1·80	2·80	2·60
Digestible fibre	20·80	19·80	8·28	10·62	26·73	26·35	32·24	31·17
Indigestible woody fibre	33·92	30·27	6·50	9·24	43·74	40·25	25·26	27·14
Soluble inorganic matter	4·05	3·15	1·78	1·88	5·20	4·20	6·93	5·53
Insoluble mineral matter	4·50	3·70	0·77	0·82	5·78	4·93	3·00	2·40
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen	0·115	0·140	0·255	0·336	0·149	0·186	0·992	0·990
** Containing nitrogen	0·755	1·120	0·221	0·226	1·020	1·490	0·860	0·665
Total percentage of nitrogen	0·910	1·260	0·476	0·562	1·169	1·676	1·852	1·655
Equal to total protein compnds.	5·760	7·970	3·010	3·557	7·400	10·630	11·72	10·470

of the material with water these essential flavours were carried over into the distillate, but, though powerful, the quantity of actual oil was too small to be separated.

The hay treated in precisely the same manner gave no trace of essential oils, or any flavour whatever except that of decaying grass.

In addition to the detailed analyses recorded in the Tables, the ensilages Nos. 1 and 2 were both examined for the amount of acidity; this was found to be very much the same in both samples, and taking it as acetic acid, the proportion was found to be respectively 0·34 and 0·36, or about one-third of a per cent.

The alcohol was estimated in No. 2 ensilage, and amounted to 0·055 per cent by weight, or about one-tenth of a per cent of proof spirit.

These proportions are very small, and they arise of course from the conversion of a small proportion of saccharine matter in the original grass, but their development is open to no objection when kept within moderate limits; on the contrary, they add to the fragrancy and taste of the substance, and undoubtedly render it more acceptable, and probably more digestible, as a food.

If the effects of the silo were only to render what would otherwise be a tasteless, dry forage into a fragrant, appetising, and succulent food, it would be a decided step in advance; but the analyses will show that much greater changes of a beneficial nature occur during the process. These changes are especially shown in the large proportions of soluble flesh formers and fat producers as compared with the hay.

For instance, in the case of No. 1 ensilage, the soluble albumenoids (or flesh formers) are increased more than six times, and in No. 2 more than five times; while in the case of sugar, gum, and extractive matters the proportion is nearly doubled in both instances.

The digestible fibre is also increased fully 20 per cent in both samples of ensilage.

These facts are of great importance and well worth the attention of all stock-feeders, as it is evident that the occurrence of these nutritious constituents in a readily soluble form is so much labour of mastication and digestion saved to the animals who are fed on such food as compared with dry hay.

The change induced by the silo is, in fact, a partial digestion or limited fermentation, and undoubtedly such food will prove much easier of digestion and assimilation than crude hay.

There are apparently two anomalies in the figures of analysis which it may be proper to notice. The first is the apparent increase in fatty matters in the ensilages as against the hays; this probably arises from matters like chlorophyll, &c., which are converted into a less soluble form in the process of drying through which the hay has passed.

The second is in the amount of nitrogen found in No. 1 ensilage as compared with its hay.

The total protein compounds (flesh formers) are recorded as being 4 per cent higher. This can hardly be the fact, as, of course, the silo has no power to originate nitrogenous constituents; it can only modify them. The difference probably arises from one of two things—either that the sample of ensilage taken for analysis contained rather more of the seed vessels, or other richer nitrogenous portions of the plant, than the corresponding sample of hay, or it may be due entirely to the different periods of growth.

In conclusion, it is abundantly evident, so far as these analyses can show, that the silo has produced a succulent, easily-digestible food, full of aroma and nutrition, from a very poor quality of grass.

Destruction of Bricks. — M. Parive traces the disintegration of bricks to a microscopic organism, the action of changes of temperature being merely secondary. —*Cosmos les Mondes.*

ON THE

APPLICATION OF HYDROGEN PEROXIDE IN CHEMICAL ANALYSIS.

By A. CLASSEN and O. BAUER.

Hydrogen peroxide has hitherto met with no application in analytical laboratories as an oxidising agent, a circumstance due to the fact that it has been difficult to procure in a pure and sufficiently concentrated state. A solution containing 3 to 4 per cent is now prepared by Carl Roth and Co., of Berlin, and may be had acidulated either with hydrochloric or with sulphuric acid.

It is already known that hydrogen peroxide oxidises arsenious acid to arsenic, and phosphorous acid to phosphoric; also that hydrogen sulphide is converted into water with liberation of sulphur. The latter reaction does not occur if the hydrogen peroxide is applied in an ammoniacal solution. If ammonium or sodium sulphide is mixed with hydrogen peroxide heat is evolved, and the liquid is decolourised without the slightest separation of free sulphur. The liquid is found to contain a sulphate and a hyposulphite. But if, after adding the hydrogen peroxide, the mixture is heated for some time to a boil, a sulphate alone is produced.

On passing hydrogen sulphide into a solution of hydrogen peroxide placed in an absorption apparatus, and rendered strongly alkaline with ammonia, sodium carbonate, or potassa, the transitory formation of ammonium, &c., sulphide is observed at the point of entrance; but here also complete oxidation to sulphuric acid takes place.

If to solutions of tin, antimony, and arsenic sulphide in ammonium sulphide, hydrogen peroxide is gradually added, the ammonium sulphide is first oxidised, and there appear transient precipitates of the metallic sulphides. If an excess of the reagent is used, and the mixture is heated, the tin sulphide passes completely into insoluble oxide, the antimony partly into insoluble oxide, but partly into a soluble antimony compound, whilst the arsenic entirely becomes a soluble arseniate. If hydrogen peroxide acts upon sodium-tin sulphide, then, according to the quantity of the sodium sulphide present, either the whole or the larger portion of the tin remains in solution.

The behaviour of hydrogen peroxide with ammonium sulphide, or of hydrogen sulphide with ammoniacal hydrogen peroxide, may therefore be used qualitatively for the destruction of these compounds, and quantitatively for determining hydrogen sulphide, whether gaseous or in solution, and for determining the sulphur or the metal in metallic sulphides. In cases where the sulphide can be decomposed by the direct action of hydrogen peroxide in presence of ammonia, it takes place in this manner; in other cases, as in the sulphides which on heating with hydrochloric acid evolve definite quantities of sulphuric acid, it takes place by conversion into sulphuric acid or barium sulphate. Just as hydrogen sulphide or metallic sulphides are oxidised to sulphuric acid or to sulphate, sulphurous acid and sulphites are oxidised to sulphuric acid or sulphates. These reactions may be utilised in various directions.

Several metallic sulphides are completely oxidised by ammoniacal hydrogen peroxide without the formation of precipitates, as the sulphides of arsenic, copper, zinc, and thallium. After the expulsion of the ammonia all the copper is deposited by a copper solution as a dirty green precipitate, not changed by ignition. From the zinc solution only a part of the zinc is separated as a white deposit. On the action of hydrogen peroxide upon antimony trisulphide a part of the antimony separates as a white precipitate, whilst the liquid contains all the sulphur as sulphuric acid. Tin sulphide is decomposed in a similar manner, oxide being deposited and the sulphur oxidised to sulphuric acid. With the other metallic sulphides the behaviour of hydrogen peroxide is very various. It attacks mercury sulphide, which is scarcely affected by nitric acid,

very energetically. After the expulsion of the mercury there remains a spongy precipitate which settles quickly, dissolves in hydrochloric acid, and is converted into a white powder by the action of nitric acid. After the conversion of mercury sulphide by the action of hydrogen peroxide, no mercury can be detected in the filtrate. Cadmium sulphide is decomposed with formation of a yellowish white precipitate, easily soluble in hydrochloric acid. When the oxidation is completed a part of the cadmium remains in the filtrate as sulphate.

Certain metallic sulphides, the solutions of which in acids are precipitable by ammonia, are decomposed by hydrogen peroxide with formation of sulphuric acid and separation of hydroxides; thus iron sulphide, which is oxidised as just mentioned, and manganese sulphide, which is quickly and completely decomposed with formation of sulphuric acid and separation of a mixture of hydrated peroxide and oxide. On heating cobalt sulphide with ammoniacal hydrogen peroxide there is first formed soluble cobalt sulphate, which on prolonged heating is further attacked with formation of a dirty brown precipitate. Nickel sulphide is decomposed in the same manner, with formation of a green precipitate which does not contain all the nickel. Silver and bismuth sulphides are not attacked by ammoniacal hydrogen peroxide; lead sulphide is readily converted into sulphate.

It remains to examine the several precipitates more closely, and ascertain whether the different behaviour of the sulphides with hydrogen peroxide can be used for effecting separations.

The property of hydrogen peroxide in alkaline solution, of easily and completely oxidising hydrogen sulphide to sulphuric acid, may be used, in the first place, for the determination of hydrochloric, hydrobromic, and hydriodic acids in liquids containing hydrogen sulphide. These determinations have occasioned much trouble to analysts.

For the determination of hydrochloric acid along with hydrogen sulphide an ammoniacal solution of hydrogen peroxide is added, and the mixture is boiled until no more bubbles of oxygen rise up. Nitric acid and silver nitrate are then added, and the silver chloride is determined in the usual manner.

For hydriodic acid in presence of hydrogen sulphide the procedure is similar, but the hydrogen peroxide is used mixed not with ammonia, but with sodium carbonate. The mixture is boiled as before, and silver nitrate is added, and nitric acid until a faintly acid reaction is produced.

In estimating hydrobromic acid under similar circumstances the process is exactly the same as for hydriodic acid.

In the metallic sulphides capable of direct oxidation by hydrogen peroxide the quantity of metal can be calculated from the sulphuric acid formed. This method is applicable to the sulphur compounds of arsenic, antimony, zinc, copper, and cobalt. The sulphide is dissolved in ammonia, treated with sufficient hydrogen peroxide, boiled to expel excess, the liquid is acidulated with hydrochloric acid, and the sulphuric acid precipitated with barium chloride.

Antimony trisulphide is treated exactly like arsen trisulphide. Antimony penta-sulphide is incompletely oxidised by hydrogen peroxide.

Sulphides which dissolve by boiling with hydrochloric acid, with liberation of hydrogen sulphide, can be rapidly and accurately determined by converting the latter compound into sulphuric acid. This principle has been used by one of the authors for years in determining the sulphur in ultramarine, in crude iron, &c., the agent for oxidising the sulphur being a solution of bromine in hydrochloric acid.—(Classen, "Quantitative Analysis," 2nd edition, p. 28.)

The unpleasant properties of bromine, and the circumstance that the precipitation of the sulphuric acid must be preceded by the expulsion of the excess of bromine and hydrochloric acid, during which operation sulphur is often separated, render this method objectionable. Hydrogen peroxide offers the great advantage that the precipitation of the sulphuric acid can take place at once after completion of the manipulations, the liquid containing no substances which can interfere with the separation of pure barium sulphate.

The determination of the metal from the quantity of the hydrogen sulphide evolved is capable of more general application than the determination by the direct oxidation of sulphur to sulphuric acid. In analytical operations there result, as a rule, not pure sulphides, but mixtures containing more or less free sulphur. Thus the determination of tin is almost always preceded by a separation consisting in treating the sulphides with sodium or ammonium sulphide; from these solutions the sulphides are separated again, accompanied by abundance of sulphur. The determination of antimony and tin in these mixtures is no easy task, and in any case it involves the expenditure of much time.

The authors have endeavoured to determine a number of metallic sulphides in the manner indicated, and have obtained very satisfactory results as regards accuracy and speed.

For the determinations they have used the apparatus which one of them has proposed for the estimation of hydrogen sulphide and carbonic acid.—(Classen, "Quant. Analyses," pp. 28 and 239.)

The small flask which serves to receive the metallic sulphide to be decomposed is closed with a stopper having three perforations. Into one passes the delivery-tube, into the second a funnel-tube, and into the third a tube for introducing carbonic acid. The delivery-tube is surrounded with a refrigerator, which serves to condense hydrochloric acid, and is connected with a second perpendicular glass tube filled with glass globules, and in which the hydrogen sulphide is oxidised by hydrogen peroxide constantly trickling down. The liquid which collects can be let off by a glass cock. In order to drive all hydrogen sulphide out of the liquid and the apparatus into the tube filled with glass globules, the entrance tube is connected with a Kipp's carbonic acid apparatus. The substance to be decomposed is placed in the flask, about 50 c.m. dilute hydrochloric acid are allowed to enter through the funnel-tube, and a moderately strong current of carbonic acid is then caused to pass through the liquid. At the same time an ammoniacal solution of hydrogen peroxide (or under certain circumstances a solution mixed with soda, potassa, or sodium carbonate) is caused to fall, drop by drop, into the tube filled with glass-globules escaping below, in such a manner that one-third of the tube remains always filled with the liquid. The contents of the flask are heated to a boil. The whole operation is complete in from fifteen to twenty minutes. After rinsing out the absorption-tube with water the liquid, collected in a covered beaker set below the tube containing the glass-globules, is cautiously acidified with hydrochloric acid, boiled in order to decompose hydrogen peroxide, and precipitated with barium chloride. The authors observe that the precipitate of barium sulphate is more granular than usual, subsides very readily, and is easy to filter. In this manner the antimony sulphides were determined, and gave good results.

Tin sulphide was dissolved in sodium sulphide, precipitated with dilute sulphuric acid, washed, placed along with the filter in the flask of the above-described apparatus, and decomposed with dilute hydrochloric acid.

As arsen sulphide is not decomposed by dilute hydrochloric acid, the authors attempted to use this reaction for the determination of tin and antimony in presence of arsenic. The results were quite unsatisfactory.

The determination of cadmium sulphide was satisfactory, as also that of iron sulphide.

The determination of sulphurous acid in any sulphite is conducted on exactly the same principles as that of hydrogen sulphide in a metallic sulphide. If the sulphite contains no sulphate the conversion into sulphuric acid may be effected by the direct action of an alkaline solution of

hydrogen peroxide. In the other case the sulphurous acid is expelled by boiling with dilute hydrochloric acid, and the sulphur dioxide is oxidised like hydrogen sulphide.

Sodium hyposulphite is decomposed on boiling with hydrochloric acid, sulphur being deposited and sulphur dioxide formed. This method permits of the determination of sodium hyposulphite, sulphite, and sulphate, when occurring together. The weighed substance is decomposed in the apparatus by means of hydrochloric acid, the sulphur dioxide corresponding to the sulphite and hyposulphite is determined, the sulphur remaining in the flask is weighed on a tared filter, and the sulphuric acid in the filtrate is precipitated as barium sulphate. From the quantity of the sulphur that of the hyposulphite is calculated.—*Berichte Deutsche Chem. Gesell.*

ON THE

ACTION OF CERTAIN VEGETABLE ACIDS ON LEAD AND TIN.*

By FRANCIS P. HALL.

THE enormous and continually increasing use of canned goods—fruit, vegetables, meat, &c.—has led to the discussion, on sanitary grounds, of the possible injurious effect of the material of the can on its contents; and among other chemical questions is that of the effect of various vegetable acids upon the material of the cans, *i.e.*, upon the can itself and upon the solder which may be exposed on the inside. The fear also has arisen lest the tin-plate itself of which the cans are made should, for the sake of greater cheapness, be made not with pure tin, but with an alloy of lead and tin.

The following paper contains the results of experiments on the action of certain acids on tin and on alloys of tin and lead, and also the results of some investigations as to the quality of the tin-plate and tin-foil in actual use as envelopes for food products.

On the Action of Vegetable Acids on Alloys of Lead and Tin.

One of the most important things to be considered in investigating the power of an alloy to resist corrosion is the electrical relation of the metals which compose it. Lead and tin are so nearly alike in this respect that their relation to each other may be reversed in different liquids, or even in the same liquid under different circumstances. On this subject chemical literature contains many and quite discordant statements. It seems, however, to be fully established by the experiments of Weber† that ordinary vinegar will dissolve lead from an alloy of lead and tin containing only 5 per cent. of lead, and further, that from a dilute acidulated solution of acetate of lead, lead is precipitated by an alloy containing as little as 5 per cent of tin.

In the following investigation I wished to ascertain quantitatively the action of several of the more common vegetable acids, all quantitative experiments that I had seen being made with acetic acid only.

To ascertain definitely the effect of alloying on the corrosion of the metals, the amount of lead or tin dissolved when pure must be compared with the amount dissolved, under the same conditions, from an alloy exposing the same surface of the metals in question. To make the experiment, as is usually done, with equal sized pieces of pure metal and alloy is not fair, if we consider the action to be proportional to the surface of metal exposed, because then the united surface of the two pieces of pure metal is twice that of the alloy and the surface of either metal exposed in the alloy is less than that exposed by the piece of pure metal.

To overcome this difficulty I proposed to proportion the size of the pure metal plates according to the composition of the alloy. In order to proportion them more easily and to have them of a size readily comparable with one another, I took into account the specific gravity of the metals in making the alloys. Hence, barring the unequal contraction of the metals on alloying, I had alloys exposing a known surface of lead and tin. I could now expose an equal surface of pure metal to the same acid under the same conditions and compare the action, thus getting a fair idea of the effect of alloying the metals, as well as the action of the acid on a known surface of pure lead or tin.

I made after this plan three alloys—one with equal parts of lead and tin, one with an excess of lead, and one with an excess of tin. These were all I had time to experiment with, but the researches of Weber* show that, for acetic acid at least, the action on the alloys increases quite regularly as the proportion of lead increases; therefore the action on alloys containing lead and tin in different proportions than those I took can be inferred with fair accuracy by interpolation.

The alloys were made from pure lead and tin, well stirred when melted, then cast in thin sheets in iron moulds. Afterwards these sheets were rolled into thin strips and trimmed to the size desired. Strips of pure lead and tin were made at the same time. The tin used was Banca tin, containing 99·78 per cent. of tin, a trace of lead and a trace of copper.

For acids I used a solution of glacial acetic acid in distilled water, which, on titration with a standard solution of ammonia, proved to have a strength equal to 5·75 per cent. of acetic acid; also solutions of crystallised tartaric and citric acids, which neutralised the same amount of ammonia.

The tartaric and citric acids contained, as they always do, a trace of lead, but the amount was much too small to appreciably influence the results.

Strips of the alloys 1·2 inch wide and 12 inches long were cut out, exposing, therefore, counting both sides, 28·8 square inches or one-fifth of a square foot. Pieces of pure lead and tin were taken of the same width, but varying in length to suit the composition of the alloy to which each corresponded. These strips of metal were rubbed until perfectly bright, washed with a little dilute alcohol, heated in a drying closet, and when cool weighed. Immediately after weighing they were put into separate beakers each containing 200 c.c. of acid. The long strips were coiled and kept off the bottom of the beaker by a ⋁ of glass rod. In each case the liquid covered the metal by more than an inch, so that the air did not take part directly in the action. Each beaker was covered with a watch glass.

After standing for two weeks in a place where the temperature varied from 25° to 35° Centigrade, the contents of the several beakers were examined. The most notable change was that the acid containing the tin, as well as that containing the alloys, had a decided yellowish tint, while that containing the lead was perfectly clear and colourless. The metal in all cases was more or less tarnished, but the tin much more noticeably so than the lead. Two of the alloys in the acetic acid were sprinkled with little black crystals. These crystals were evidently metallic; they were carefully collected, washed with alcohol, dried and analysed. The result of the analysis is given later. The smallest of the pieces of lead in the tartaric acid was covered with small transparent crystals; these were set aside for further examination. The pieces of tin were covered with a dusty powder, but there was not enough of it to analyse.

When the contents of each beaker had been carefully examined, the strips of metal were lifted out, washed with a jet of water, dried with a soft towel, and, after remaining a while in a drying closet, weighed. The loss of weight served as a rough check on the subsequent

* *American Chemical Journal*, vol. iv., No.6.

† *Dingl. Polyt. Journ.*, 232, pp. 153, 264; Wagner, *Jahresb.*, 1879, 196-207.

* *Loc. t.*;

TABLE I.

Kind of Acid.	Surface exposed, in sq. inches.		Percentage composition.		Loss of weight, in grms.	Found in solution, in grms.		Percentage of dissolved metals.		Total amount dissolved (in grms.) from	
	Lead.	Tin.	Lead.	Tin.		Lead.	Tin.	Lead.	Tin.	Alloys.	Pure Metals.
Acetic ..	7·2	—	100·0	—	0·4320	0·4216	—	—	—	—	—
„ ..	7·2	21·6	34·1	65·9	0·4525	0·0432	0·3312	11·54	88·46	0·3744	0·7122
„ ..	—	21·6	—	100·0	—	—	0·2906	—	—	—	—
„ ..	14·4	—	100·0	—	0·5470	0·5444	—	—	—	—	—
„ ..	14·4	14·4	60·8	39·2	0·5145	0·0558	0·3552	13·57	86·42	0·4110	0·8242
„ ..	—	14·4	—	100·0	0·2820	—	0·2798	—	—	—	—
„ ..	21·6	—	100·0	—	0·6195	0·6137	—	—	—	—	—
„ ..	21·6	7·2	80·84	19·16	0·6570	0·4887	0·1589	75·46	24·54	0·6476	0·8073
„ ..	—	7·2	—	100·0	0·2135	—	0·1936	—	—	—	—
Tartaric ..	7·2	—	100·0	—	—	0·0452	—	—	—	—	—
„ ..	7·2	21·6	34·1	65·9	0·0280	0·0029	0·0269	9·73	90·27	0·0298	0·0664
„ ..	—	21·6	—	100·0	0·0210	—	0·0212	—	—	—	—
„ ..	14·4	—	100·0	—	0·6605	0·0586	—	—	—	—	—
„ ..	14·4	14·4	60·8	39·2	0·0385	0·0042	0·0332	11·23	88·77	0·0374	0·0750
„ ..	—	14·4	—	100·0	0·0150	—	0·0164	—	—	—	—
„ ..	21·6	—	100·0	—	0·0655	0·0654	—	—	—	—	—
„ ..	21·6	7·2	80·84	19·16	0·0345	0·0080	0·0269	22·92	77·08	0·0349	0·0787
„ ..	—	7·2	—	100·0	0·0115	—	0·0113	—	—	—	—
Citric ..	7·2	—	100·0	—	0·3540	0·3521	—	—	—	—	—
„ ..	7·2	21·6	34·1	65·9	0·1690	0·0165	0·1461	10·15	89·85	0·1626	0·4785
„ ..	—	21·6	—	100·0	0·1175	—	0·1264	—	—	—	—
„ ..	14·4	—	100·0	—	0·4355	0·4348	—	—	—	—	—
„ ..	14·4	14·4	60·8	39·2	0·1725	0·0210	0·1355	13·42	86·58	0·1565	0·5439
„ ..	—	14·4	—	100·0	0·1080	—	0·1111	—	—	—	—
„ ..	21·6	—	100·0	—	0·4870	0·4875	—	—	—	—	—
„ ..	21·6	7·2	80·84	19·6	0·2305	0·0982	0·1221	44·58	55·42	0·2203	0·5946
„ ..	—	7·2	—	100·0	0·1030	—	0·1071	—	—	—	—

analysis of the solutions. Next, the metal in solution was precipitated by sulphuretted hydrogen. The lead caused dense black precipitates, much finer in the tartaric and citric acid than in the acetic. The tin in the acetic acid came down of a dark brown colour, showing the stannous salt, while that in the tartaric acid gave, at first, merely a yellow colouration. After standing some time, however, a flocculent, apparently hydrated precipitate settled out. The same seemed to be the case with the citric acid solutions, but on closer examination an almost transparent precipitate could be seen, and it settled much quicker than in the case of the tartaric acid. These same peculiarities of the precipitates of sulphide of tin were noticed throughout the whole investigation. It was also invariably the case with the alloys that the precipitates in acetic acid were dark brown, while those in tartaric and citric acids were light coloured and flocculent.

After some experimenting I found the best way to separate the sulphides of lead and tin in the solutions was to carefully decant as much as possible of the liquid through a filter, neutralise what remained with ammonia water, add a little yellow ammonium sulphide, and heat; then collect the sulphide of lead on the fileer used before. The tin was determined in the alkaline filtrate. The sulphide of lead was converted into the sulphate before weighing; the sulphide of tin into the oxide in the usual manner. In no case was either metal determined by difference.

The results obtained are given in the form of tables. The first two columns of Table I give the amount of surface of each metal exposed both as pure metal and in the alloy. The last two give the total weight of metal, lead and tin, dissolved from the alloy, and from an equal surface of the same metals exposed in the pure state. But although the surface exposed was the same, the unalloyed metals were exposed to twice as much acid, each being in a separate beaker with 200 c.c. of the acid. This might have been righted by proportioning the acid to the surface exposed, but this did not occur to me until too late. It will be noticed how often the amount dissolved when unalloyed is equal to twice that dissolved from the alloy.

The alloys Nos. 1 and 2 in the acetic acid were the ones on which the small black crystals before mentioned were found. The crystals on No. 1 weighed 0·0970 gramme, and gave on analysis 0·0931 gramme of lead, or 91 6 per cent. Those on No. 2 weighed 0·0620 grm., and gave 0·0586 grm. of lead, or 94·45 per cent. They were evidently, therefore, crystals of lead. This amount of lead might have been considered as having been in solution, but it is not included in the amount given in the tables. Weber* noticed similar crystals in his experiments, and explained their presence by supposing that, at the surface of the liquid where the oxygen of the air and the acid both acted on the metal, so much lead was dissolved that it was precipitated again by the tin of the alloy below the surface. As, in my experiments, the metal was kept entirely covered by the acid, this could hardly have been the case.

The transparent crystals found on the smallest piece of lead in the tartaric acid were nearly, if not quite, insoluble in water. Under the microscope they appeared to be hexagonal and very much like small quartz crystals. They were found, on comparison, to have the same form as crystals of tartrate of lead. From this and from a few qualitative tests I decided that they must be tartrate of lead. The crystals adhered so firmly to the lead that they could not be removed,—therefore the loss of weight, as well as the lead in them, could not be determined.

The results of the experiment agree in all essential points with those statements which I have found that have been supported by actual experiment. Those statements which would have us suppose that alloying with tin increased the corrosion of lead seem to be founded on the case of some stray tank or pipe, rather than on a well-conducted research. Moreover it does not appear, as is often supposed to be the case, that the alloy is more acted upon than either of the metals.

(To be continued.)

* *Loc. cit.*

NOTICES OF BOOKS.

Annual Report of the Chief Engineer of the Water Department to the City of Wilmington, Delaware, for the Year 1882. Also a Report of the Water Supply of Wilmington, including Sanitary Analyses of the Brandywine River, from Coatesville to Wilmington, and of Mill, White Clay, and Red Clay Creeks. By Prof. A. R. Leeds, Ph.D. Together with the Report of Prof. Ira Remsen on Samples of Water furnished him from Cool Spring Reservoir, White Clay and Red Clay Creeks. Wilmington, Delaware: James and Webb.

The growing density of population and the spread of manufactures in the United States render the domestic water-supply a difficult question. It is worthy of notice that the various municipalities, as is done in the North of England, find it prudent to keep this matter in their own hands. From the Report before us, we glean some very interesting facts. Thus the daily water-supply at Wilmington is 106 gallons daily per head,—a very large excess. The engineer recommends the introduction of water-meters, as calculated to reduce the present charges. He points out that on the existing system those who do not use or waste the water are very unfairly compelled to pay for those who do. Of all methods of charging for water that adopted in some parts of England of making it dependent upon the value of the premises is the least equitable, involving as it does the corollary that an increase in the value of a house raises the cost of water.

As far as we can judge, the supply at Wilmington is constant. The annual charge for dwelling-houses is 5 dollars for a hydrant, 3 for a bath, 2 for a W.C., wash-basins (we presume fixed, with outflow pipe) 1 dollar, hose for washing pavements 2 dollars, and water-motors for sewing machines 3 dollars.

Professor Leeds, in his Report on the quality of the water in the Brandywine River, had all his sixteen samples from different places collected on the same day. He does not find that the waters undergo any important change in the time which elapses between their collection and the actual performance of the analysis.

The determinations made have included free and albumenoid ammonia, oxygen required to oxidise organic matter, nitrites, nitrates, chlorine, hardness, total solids, mineral matter, and hardness and volatile matter. In the determination of the free and albumenoid ammonia, Prof. Leeds has followed the method of Wanklyn and Chapman, but with certain modifications. These are the employment of a colorimeter—here figured—for effecting the comparison of the test with the standard under constant conditions, and the substitution of a standard wedge, graduated with extreme care and nicety, for the various standard solutions which have to be freshly prepared for each analysis.

The determination of the oxygen required to oxidise organic matter has been effected on Kubel's method,—the use of potassium permanganate at a boiling heat. It is remarked that the figures thus obtained are higher than when a partial oxidation is effected at common temperatures, even on prolonged standing.

In determining nitrites the author makes use of Griess's reaction,—the brown colouration observed when meta-di-amido-benzol is brought in contact with nitrites, available for one part of nitrous acid in ten million parts of water, and the still more delicate test proposed by the same chemist, the pink colour produced when naphthylamine hydrochlorate and sulphanilic acid react upon nitrous acid. This test enables us to recognise one part of nitrous acid in 1000 million parts of water. Nitric acid was determined by Kübel's method,—the decolouration of indigo by the nitric acid in a strongly acidified solution. Professor Leeds lays considerable weight upon the determination of the nitrites and nitrates as giving a measure of "previous sewage contamination." But he attaches little importance to the determinations made by evaporating to dryness and subsequent ignition. He shows that the figures obtained by these operations can never represent either the total solids, the organic and volatile matter, or the mineral matter.

The remarks of Professor Leeds on the interpretation of the data obtained in water analysis may be characterised as eminently judicious, and demand the serious consideration of sanitary authorities. He admits that the chemist cannot isolate and exhibit the disease germs,—the actually dangerous ingredients. But he argues that when water contains nitrogenous organic matter, especially of a very unstable character and prone to decomposition, in abnormal amount, there is at least a reasonable presumption that those living organisms which produce specific disease may be present also. His reasoning is here analogous to that which connects an excess of carbonic acid in the atmosphere with danger to health. The carbonic acid is not dangerous *per se* in the proportions in which it ever occurs in the air, but any excess above 4 parts in 10,000 is usually accompanied by questionable exhalations from living or decaying organisms. He maintains, as a chemist of very wide experience, that whenever he has analysed a water obviously free from contamination he has found the albumenoid and free ammonia and the nitrites either very low or entirely absent. On the other hand, waters from contaminated sources as regularly show an excess of ammonia, nitrates, and nitrites. Hence he concludes that chemical analysis can give a definite answer to the inquiry as to the wholesomeness or unwholesomeness of a specimen of water.

We have spoken in expounding the author's views of an abnormal amount of nitrogenous organic matter, and we find him further speaking of standards of purity. But his standards are founded on long-continued observation and analysis of some particular river, or of a particular class of wells in a certain restricted locality. He writes,—and in our opinion with great truth,—"It will not answer to apply to wells situate at Ocean Grove the same standards as to those in New York city, nor to either the same standards as those which are applicable to a river contaminated by sewage and factory refuse, like the Passaic or the Brandywine. The water analyst, by constant comparison of his analyses with the sanitary properties of the waters analysed, becomes able to set up a standard from which the water does not depart without becoming more and more objectionable." As a maximum limit, Professor Leeds proposes, per 100,000 parts, free ammonia, 0·001 to 0·012; albumenoid ammonia, 0·01 to 0·028; nitrites, 0·0001 to 0·001; nitrates, determined by Kübel's method, 0·5 to 1·75; chlorine, 0·3 to 1·00; and oxygen required, according to Kübel's method, 0·5 to 0·7.

As regards chlorine, the maximum limit here proposed agrees with that recommended by the late Royal Rivers' Pollution Commission. For organic nitrogen, Prof. Leeds is more stringent than the Commission, which fixes no standard for free ammonia, nitrites, nitrates, or oxygen required.

The author's observations and experiments lead him to conclude that "there is no foundation in fact for the oft-repeated statement that water once polluted by sewage can never again become safe for drinking purposes." He points to the various natural purifying agencies constantly at work, giving especial prominence to the action of aquatic plants and to that of the finely-divided earth washed into rivers by the rains, the former influence oxidising and the latter occluding and precipitating organic impurities. As an instance of the efficacy of these natural agencies, he refers to the River Passaic,—pure above the town of Paterson, but polluted by the sewage and the manufacturing refuse of that town. "The river immediately below the town is black with dye-wares, the fish carried over the great falls are immediately poisoned, and I have often seen the foul-smelling and disgusting water covered with their floating carcasses." Yet samples taken at intervals of a mile apart down the

river show a regular diminution in the albumenoid ammonia, a disappearance of the nitrites, and as regular an improvement in the quality, until at a point sixteen miles below Paterson the river has returned to a condition of purity not far below that it exhibited above Paterson, and at this point it is used as a water supply of the three hundred thousand inhabitants of Jersey City and Newark. These observations agree closely with those on the Vesle, at Rheims. We are bound, however, to admit that they harmonise less with the phenomena to be recognised in the course of the Irwell and Mersey, or of the Calder and Aire. Part of the discrepancy may be traced to the relative volumes of the rivers and of the sewage, part to the difficulty of finding in the English manufacturing districts a run of sixteen or twenty miles without fresh sources of contamination, and partly to the longer continuance, with us, of the pollution. In some of our streams the deposit of earth, &c., containing putrescible organic matter has accumulated to a depth of two feet or more. On a fall of the barometer, cakes of this matter, buoyed up by the gases evolving, rise to the surface, and restore a part, at least, of the offensive substances to a state of solution.

There is a further question: We have seen and we know that organic impurities in rivers are consumed by, *e.g.*, the oxygen given off by aquatic vegetation. But does this process of destruction go on *pari passu* with living organism as with lifeless organic manner? Unless this question can be answered in the affirmative, a river once polluted may not be sufficiently purified to be safe for drinking and culinary uses. Here careful observation must be our guide.

This pamphlet, especially the report of Professor Leeds, must take rank as a valuable contribution to sanitary literature.

Report and Proceedings of the Manchester Scientific Students' Association for the Year 1882. Published by the Society, 1883.

THE Manchester Students' Association has been in active existence for twenty-one years, and seems to have done good service in bringing scientific students into mutual contact, and thus stimulating their zeal for research and enlarging their ideas. We find, however, one of the oldest members of the Association, observing with regret that, while there is a large attendance at the field meetings, the number of real students taking part in them had become more limited. "In the early days the members had a student's enthusiasm, and it was rare to see anyone at the excursions who was not diligently prosecuting some branch of natural science, whereas to-day the worker is the exception."

The total number of members of the Association is now 396. Among the papers read we may mention: "Use of Gas as a Workshop Tool," "Progress of Invention," "Secondary Batteries," "Asbestos," "Natural Crystals," "Meteorites," and "Arts and Manufactures of the Ancients."

CORRESPONDENCE.

ESTIMATION OF CHROMIUM.

To the Editor of the Chemical News.

SIR,—On referring to the CHEMICAL NEWS for Feb. 16, 1877 (vol. xxxv., p. 67), Sergius Kern, of St. Petersburg, in his estimation of chromium states that "the resulting chromium oxide (Cr_2O_3) is weighed, and the percentage is calculated, knowing that this compound contains 32·2 per cent of chromium."

I find that Cr_2O_3 contains 68·63 per cent chromium and 31·37 per cent oxygen, and should be glad if he would kindly state how he obtains the above figures.—I am, &c.,

INTERESTED.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 22, May 28, 1883.

General Considerations on Scientific Methods and Applications of the *a posteriori* Method of Newton and the *a priori* Method of Leibnitz.—E. Chevreul.—A long and discursive treatise, which does not admit of useful abstraction.

Remarks on Violet Iridium Sulphate.—Lecoq de Boisbaudran.—The author, in his last communication, has not clearly described the behaviour of green iridium sulphate with potassa in the cold. He stated that the colour changes to a pale blue, but without immediate precipitation. He should have said that the colour changes to a light blue without the immediate precipitation of the violet-blue oxide; for the initial light blue tint is due to the opalescence produced by a bulky greenish blue precipitate, which shrinks up into a green or greenish powder, which turns slowly to a violet-blue generally after having passed through a violet shade. These violet and violet-blue colourations show themselves more rapidly in heat, and appear doubtless due to an oxidation. Thus a boiling solution of green iridium sulphate, if supersaturated with boiling potassa, takes at first merely a very light violet shade. If agitated in presence of air the violet tint deepens, turning more to a blue, and the dark violet-blue oxide is deposited. In an atmosphere of hydrogen, neither a violet nor a blue colour appears, even in heat, but the reaction takes place as soon as air is introduced into the alkaline liquid. The re-introduction of the current of hydrogen causes the violet or the blue tint to disappear anew, the precipitate retaining merely a grey shade. Sulphurous acid at first turns the violet iridium sulphate blue, and then decolourises it entirely. When the violet blue oxide has been dried, or even submitted to prolonged ebullition, it is only partially soluble in dilute sulphuric acid. The aqueous solution of the pansy-violet sulphate loses almost entirely its colouration if boiled for a long time; if it is then supersaturated with potassa it becomes coloured again, and gives an abundant violet-blue precipitate, soluble in dilute sulphuric acid with a colour decidedly more blue than that of the original pansy-violet sulphate. The same transformations take place in the cold, but more slowly. The colour of the violet sulphate turns to a bluish, becoming fainter at the same time. Hydrochloric acid dissolves the violet-blue oxide, yielding a pansy-violet solution, which passes successively to a blue, a green, and finally to an orange-yellow. Heat greatly accelerates the reaction. The author adds that the rose reaction (C), mentioned in his last communication but one (*Comptes Rendus*, 1883, p. 1339), appears still more sensitive than the blue reaction (B). It is certain that if B has failed in consequence of the two free addition of ammonium nitrate, it is sufficient to throw a little ammonium chloride upon the hot assay, when a very distinct rose colouration is developed.

Transfer of Mechanical Energy.—Marcel Deprez.—The author shows that the intensity of the current depends only on two variables: the economic yield which it is wished to obtain, and the ratio of the mechanical work of the recipient to the total resistance of the circuit.

Connexion between Eclipses and Terrestrial Magnetism.—P. Denza.—The conjunction of two heavenly bodies in eclipses of the sun, and their opposition in eclipses of the moon, have no influence upon the magnetic elements of the earth.

Hydrates of Baryta.—M. Lescœur.—Barium oxide forms three hydrates with, respectively, 1, 2, and 9 mols.

of water. The second of these compounds loses half its water at the temperature of 100° in a vacuum, and is converted into the mono-hydrate.

Composition of the Mineral Water of Montrond (Loire).—A. Terreil.—The water in question is charged with sodium bicarbonate, and is strongly ferruginous, besides containing small quantities of arsenic and phosphoric acids and iodine.

Certain Compounds belonging to the Group of Creatines and Creatinines.—E. Duvillier.—The author has studied the action of cyanamide upon methyl-amido-α-caproic acid and the corresponding ethyl compound.

Panary Fermentation.— G. Chicandard.— The fermentation of bread does not consist in a hydration of the starch, followed by alcoholic fermentation. It is not determined by a *Saccharomyces*. It consists in a transformation of a portion of the insoluble albumenoids of the gluten, first, into soluble albumens, and finally into peptones. The starch is only modified by baking, which forms soluble starch in great quantity, and a little dextrine, the latter especially in those portions which have been most strongly heated. The agent in panary fermentation is a bacterium which is developed normally in the paste, and beer-yeast merely accelerates this development.

A Saccharine Substance obtained from the Lungs and the Sputa of Phthisical Patients.—A. G. Pouchet.—The aqueous solution of this salt is altered with great rapidity on exposure to the air, whilst lactic and butyric acids appear in the liquid. The solution does not immediately reduce or hydrate Fehling's liquid. On prolonged boiling there is a slight reduction of copper in consequence of the new body being converted into glucose by hydration and oxidation.

On Condiments, and in Particular on Salt and Vinegar, from an Alimentary Point of View.—C. Husson.—Salt, in slight proportions, facilitates digestion, but if it exceeds from 5 to 10 grms. per half kilo. of food it acts injuriously by rendering the muscular fibre more resistant to the gastric juice and by retarding the gastric fermentation. Similar conclusions apply to the organic acids. Incidentally the author remarks that it is not easy to reckon on the effects of the pepsines of commerce.

Justus Liebig's Annalen der Chemie,
Band 218, Part 2.

Action of Aldehyds upon Ketons, Malonic Acid, and Acetacetic Ether.—L. Claisen.—The author has examined the action of benzaldehyd upon certain ketons and ketonic acids in presence of hydrochloric acid, and found that aceton combines with benzaldehyd, forming, according to circumstances, mono- or dibenzal-acetone. In the same manner he obtains from acetophenon, benzal-acetophenon, and from pyruvic acid, benzal-pyruvic acid.

Action of Fatty Aldehyds upon Malonic Acid and Ethyl-malonate.—T. Komnenos.—The author investigates the condensation of acetaldehyd and malonic acid, ethyliden-acetic acid and ethyliden-diacetic acid. He then examines the action of acetaldehyd upon malonic ether, ethyliden-malonic ether, and ethyliden-dimalonic ether. He saponifies ethyliden-malonic ether with baryta water and with aqueous alcoholic potassa. He also studies the behaviour of propyl-aldehyd with malonic acid, and the formation and properties of propyliden-acetic and diacetic acids.

Condensations of Acet-acetic Ether with the Aldehyds.—L. Claisen and F. E. Matthews.—An examination of acet-ethyliden-acetic ether, acet-isobutyliden-acetic ether, acet-isamyliden-acet ether, acet-trichlor-ethyliden-acetic ether, acet-furfural-acetic ether, acet-benzal-acetic ether, the hydrochloric compounds of acet-benzal-acetic ether, the action of benzaldehyd upon mono- and diethyl-acet-acetic ether, benzal-acet-ethyl-acetic ether, the corresponding diethyl compound, and the dibromide of this ether.

Action of Benzaldehyd upon Malonic Acid and Malonic Ether.—L. Claisen and L. C ismer.—The authors have obtained and examined benzal-malonic ether, benzal-malonic acid, and have further studied its behaviour with water, its reduction, its behaviour with bromine, and the saponification of benzal-malonic ether with alcoholic potassa.

On Meta-amido-benzamid. — Hugo Schiff. — The mixed nitro-benzoic acids are separated as barium salts according to Griess's method, and the meta-acid is treated with an equivalent quantity of phosphorus chloride. After the product has been gradually heated to 140° in order to remove the greater part of the phosphorus oxychloride, it is poured in a thin stream and with stirring into strong, well-cooled ammonia, and after some hours the crystalline nitro-benzamid is filtered off, washed with water, recrystallised, and converted into amido-benzamid by treatment with colourless ammonium sulphide. If pure benzoic acid has been employed the yield is almost theoretical.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir on benzo-quinone by Dr. B. Scheid, and a paper on saponine by Dr. E. Stütz.

Bulletin de la Société Chimique de Paris.
No. 11, June 5, 1883.

On Prout's Hypothesis.—Max Gerber.—This memoir will be inserted at length.

Study on the Combustion of Explosive Gaseous Mixtures: Speed of Propagation of Combustion.—MM. Mallard and Le Chatelier.—Concluded from pages 2, 98, 268, and 369 of the present volume.

New Class of Boro-tungstates.—D. Klein.—The author obtains a barium boro-decitungstate by treating a boiling concentrated solution of sodium para-tungstate with three-quarters of its weight of boric acid, and adding to the dense mother-liquor an excess of pure barium chloride in a hot saturated solution.

Researches on the Action of Zinc-ethyl upon the Amines and Phosphines: New Method for Characterising the Nature of these Bodies.—H. Gal.—On causing zinc-ethyl to react upon an ammoniacal derivative in which all the hydrogen is not replaced we obtain a metallic derivative, whilst ethyl hydride is disengaged. These reactions are in general very energetic, and it is well to moderate them by using the zinc-ethyl in an ethereal solution. Zinc-ethyl is without action upon the tertiary amines and phosphines. Hence we have a new and easy method for determining to what class an amine belongs. It is merely necessary to place in test-tubes a small quantity of different bases, pouring upon each an ethereal solution of zinc-ethyl. In the tubes containing a tertiary amine we perceive no reaction, whilst in the others there is a regular and abundant disengagement of a combustible gas, ethyl hydride. Reciprocally, if an amine or a phosphine thus treated gives off ethyl hydride it should be considered as containing ethyl hydride. As regards the natural bases, zinc-ethyl is without action upon nicotine and quinoleine, but it attacks the greater number of the oxygenated natural bases, forming organo-metallic compounds, which require further study.

Cosmos Les Mondes.
Tome v., No. 3, May 19, 1883.

Combination-Heats of the Soluble Compounds of Copper.—Dr. D. Tommasi.—A table of combination-heats as calculated and as found experimentally.

No. 4, May 26, 1883.

This issue does not contain any chemical matter which has not appeared elsewhere.

No. 5, June 2, 1883.

New Lighting Appliance.—M. de Khotinsky.—The author directs a jet of coal-gas and of oxygen upon a prismatic pencil of magnesia prepared in an especial manner. The gas and the oxygen arrive by two separate pipes inclosed in the same tube.

Reflections on a Point of Thermo-chemistry.—Marcellin Langlois.—The author insists on the necessity of establishing in all possible cases the efficacity of the fundamental principle of thermo-chemistry, *i.e.*, that in order to decompose any substance we must expend the same quantity of energy which was liberated at its formation in the shape of heat. He requests thermo-chemists to determine the quantity of heat liberated in the reaction of chlorine upon yellow mercury oxide.

No. 6, June 9, 1883.

Combination-heats of the Soluble Compounds of Cobalt.—Dr. D. Tommasi.—A comparative table of the heats as calculated and as experimentally determined.

The Magnet and the Magnetic Needle.—Claudio Giordano.—The author maintains that Gilbert was anticipated in his researches on magnetism, not merely by Fra Paolo Sarpi, but by J. B. Porta, Cardan, Mairolico, and others.

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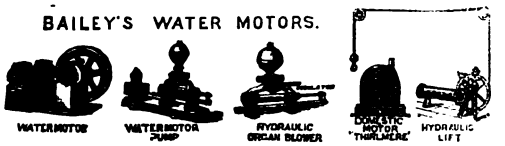

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THE CHEMICAL NEWS.

VOL. XLVII. No. 1231.

REPLY TO A NOTE BY PROFESSOR J. E. REYNOLDS ON THE ATOMIC WEIGHT OF GLUCINUM OR BERYLLIUM.*

By T. S. HUMPIDGE, Ph.D., B.Sc.

IN the above-mentioned note of Professor Reynolds† the author criticises the results detailed in a paper which I recently had the honour to contribute to the Society,‡ and draws an inference from the specific heats of different specimens of the metal which I shall show to be incorrect.

Professor Reynolds remarks that all the results obtained by Nilson and myself tend in one direction, viz., to an increased specific heat as the impurities in the metal diminish. This, however, is clearly not the case, as the following comparison shows. Taking the three samples of which the specific heat has been determined in their order of purity, we have :—

	Percentage of Glucinum.	Specific Heat at 45° to 50°.
Nilson	87·09	0·4084
Humpidge..	93·97	0·4453
Nilson	94·41	0·4246

In other words, Nilson's picked sample of 2 decigrms., which was purer than mine by 0·5 per cent, has a specific heat about 5 per cent lower. On the other hand, as I have already stated, my result is probably slightly too high, owing to the heat produced on the absorption of the turpentine by the porous metal. In Nilson's experiments the metal was enclosed in a platinum capsule.

The results cannot, therefore, be explained away in this manner, nor does it seem possible that the specific heat of the *fused* metal could be as much as 50 per cent greater than in the crystalline state. It rather appears that glucinum is either an exception to Dulong and Petit's law of atomic heats or to Mendeleef's periodic law. I hope shortly to contribute some further evidence to the solution of this exceedingly interesting question, and am now making preparations for a revision of the specific heats of the solid elements in the pure state, and at different temperatures.

Next with regard to the purity of the metal as prepared by my process. The 7 decigrms. which were used for the determination of the specific heat was the first sample prepared, and included all I had then extracted. It ought not, therefore, to be compared with Nilson's picked 2 decigrms., but rather with his first sample, containing 13 per cent of impurities. Since sending in my paper I have prepared more than 3 grms. of much purer metal, and can now obtain any quantity in yields of 3 to 5 decigrms. for each experiment. The metal is decidedly crystalline in structure, mostly in thin plates of a high metallic lustre, and of a greyish colour resembling iron. No accurate analysis of these samples of the metal has been made, as it has been nearly all used for the attempted preparation of organo-glucinum compounds. But in my next contribution to the Society I hope to be able to give accurate analyses of several samples.

I only briefly alluded to the theoretical aspects of the question in my paper, and do not intend to refer to this until I have more evidence to offer than a determination of the specific heat between 10° and 100° C.; but the very remarkable result arrived at by Professor Hartley from spectroscopic evidence cannot be left unnoticed. This chemist concludes from his experiments that glucinum is a dyad metal, and that its homologues are calcium, strontium, and barium—elements with which it has not the slightest analogy. And it seems strange that Prof. Hartley should consider some slight spectroscopic resemblance between glucinum and the metals of the alkaline earths to outbalance all the weighty chemical and physical differences between them. Glucinum differs strikingly from the metals of the alkaline earths, both in the free state and combined as oxide, as hydrate, carbonate, oxalate, chloride, fluoride, sulphate, &c. If glucinum is really a dyad metal (which may *possibly* be the case), its nearest homologues are decidedly magnesium and zinc; not calcium, strontium, and barium.

* A Paper read before the Royal Society, June 21, 1883.

† Read May 24, 1883; see CHEMICAL NEWS, vol. xlvii., p. 251

‡ Read April 12, 1883; see CHEMICAL NEWS, vol. xlvii., p. 181.

SUPPLEMENT TO FORMER PAPER ENTITLED "EXPERIMENTAL INQUIRY INTO THE COMPOSITION OF SOME OF THE ANIMALS FED AND SLAUGHTERED AS HUMAN FOOD:" COMPOSITION OF THE ASH OF THE ENTIRE ANIMALS, AND OF CERTAIN SEPARATED PARTS.*

By SIR JOHN BENNET LAWES, Bart., LL.D., F.R.S., F.C.S., and JOSEPH HENRY GILBERT, Ph.D., LL D., F.R.S., V.P.C.S.

IN a former paper (*Phil. Trans.*, Part II., 1859) the authors had given the actual weights and the percentage proportion in the entire body, of the individual organs, and of certain more arbitrarily separated parts of 326 animals —oxen, sheep, and pigs—in different conditions as to age, maturity, fatness, &c. They called particular attention to the wide difference in the proportion by weight of the stomachs and intestines in the three descriptions of animal; the proportion of stomach and contents being very much the highest in oxen, considerably less in sheep, and little more than one-tenth as much in pigs as in oxen. On the other hand, the intestines and contents contributed a less proportion to the weight of the body in oxen than in either sheep or pigs, the percentage by weight in pigs being nearly twice as high as in sheep, and more than twice as high as in oxen. With these very characteristic differences in the proportion of the receptacles and first laboratories of the food, the other internal organs collectively, as also the blood, contributed a pretty equal proportion by weight of the entire body, in the three descriptions of animal.

Ten animals had been selected for the determination of the chemical composition, namely—a fat calf, a half-fat ox, and a fat ox; a fat lamb, a store sheep, a half-fat sheet, a fat sheep, and a very fat sheep; a store pig, and a fat pig. In these in the collective carcass parts, in the collective offal parts, and in the entire bodies, the total nitrogenous substance, the total fat, the total mineral matter, the total dry substance, and the water, were determined; and the results were recorded and discussed in detail.

It was shown that as the animal fattened the percentage of nitrogenous substance decreased considerably, whilst that of the fat and of the total dry matter increased in a much greater degree. It was estimated that the portions of well fattened animals which would be consumed as human food would contain between three and four times as much fat as dry nitrogenous substance; and comparing such animal food with wheat-flour bread, it was concluded that taking into consideration the much higher capacity for oxidation of a given weight of fat than of starch, such animal food contributed a much higher proportion of non-nitrogennus substance, reckoned as starch, to one of

* Abstract of a Paper read before the Royal Society, June 21, 1883.

nitrogenous substance than bread. In fact, the introduction of our staple animal foods, to supplement our otherwise mainly farinaceous diet, did not increase, but reduce, the relation of the flesh-forming material to the respiratory and fat-forming capacity of the food.

Finally, the actual amount, and the percentage of total ash, in most of the internal organs, and some other separated parts, were given. It was shown that the percentage of total mineral matter, like that of the nitrogenous substance, decreased, not only in the entire body, but especially in the collective carcass parts, as the animals matured. It was the object of the present communication to record the results of the complete analysis of the ashes of the collective carcass parts, of the collective offal parts, and of all parts of each of the ten animals. Forty complete ash analyses have been made.

As was to be expected, more than four-fifths of the ashes consisted of phosphoric acid, lime, and magnesia; these making up the largest amount in the ash of the oxen, less in that of sheep, and less still in that of pigs. Potash and soda were also prominent constituents. Assuming, for the purposes of the illustration, that one of phosphoric acid was combined with three of fixed base, the ashes of the ruminants showed an excess of base; whereas, according to the same mode of calculation, the ashes of the pigs showed no such excess.

It was, unfortunately, only in the case of the pigs that the ash of the chiefly bony, and that of the chiefly soft offal parts, had been analysed separately. The results showed a considerable excess of acid, especially phosphoric, in the ash of the non-bony portions, presumably, in part at any rate, due to the oxidation of phosphorus in the incineration.

Comparing the percentage composition of the ashes of the entire bodies of the different animals, the chief points of distinction are that, in the ash of the pig there is a lower percentage of lime, and a higher percentage of potash and soda, than in the corresponding ash of the ruminants; a somewhat higher percentage of phosphoric acid in the ash of the pigs and of the oxen than in that of the sheep; and a higher percentage of sulphuric acid (and somewhat of chlorine also) in the ash of the pigs than in that of the other animals.

A table showing the quantities of total ash, and of each individual mineral constituent, in each of the ten animals analysed was given. Not much stress was laid on the amounts in the particular animals, as the actual weights and conditions of animals coming under similar designations may vary considerably.

It was of more interest to consider the amounts of the mineral constituents in carcass parts, in offal parts, and in all parts, of 1000 lbs. fasted live-weight of each description of animal.

It was shown that a given live-weight of oxen carried off much more mineral matter than the same weight of sheep, and a given weight of sheep much more than the same weight of pigs. With each description of animal the amounts of phosphoric acid, lime, and magnesia are less in a given live-weight of the fatter than of the comparable leaner individuals. Of both potash and soda, again, the quantity is less in a given live-weight of the fatter animals. The same may be said of the sulphuric acid and the chlorine; in fact, in a greater or less degree of every one of the mineral constituents.

It was estimated that the loss to the farm of mineral constituents by the production and sale of mere fattening increase was very small. It was greater of course in the case of growing than of only fattening animals. In illustration, the amount of some of the most important mineral constituents removed annually from an acre of fair average pasture and arable land in various products may be compared. Such estimates can obviously be only approximate, and the quantities will vary considerably. With this reservation, it may be stated that, of phosphoric acid, an acre would lose more in milk, and four or five times as much in wheat or barley grain, or in hay, as in the fattening increase of oxen or sheep. Of lime, the land would lose about twice as much in the animal increase as in milk, or in wheat or barley grain, but perhaps not more than one-tenth as much as in hay. Of potash, again, an acre would yield only a fraction of a pound in animal increase, six or eight times as much in milk, twenty or thirty times as much in wheat or barley grain, and more than 100 times as much in hay.

From the point of view of the physiologist, it would doubtless have been desirable that the selection of parts for the preparation and analysis of the ash should have been different and more detailed. The agricultural aspects of the subject had, however, necessarily influenced the course of the inquiry, and the extent of the essential work had enforced the limitation which had been adopted. The results must be accepted as a substantial contribution to the chemical statistics of the feeding of the animals of the farm for human food.

ON A NEW REACTION OF THE TELLURIUM COMPOUNDS.

By E. DIVERS and M. SHIMOSE.

SULPHURIC acid dissolves tellurium dioxide or its sulphate only in small quantities, but this solution can be utilised for an exceedingly sensitive reaction for tellurium. If a little of it is poured into a hydrogen gas apparatus containing zinc and dilute sulphuric acid, and the hydrogen given off, which is mixed with hydrogen telluride, is passed into undiluted telluriferous sulphuric acid, the liquid, previously colourless, quickly takes the red colour of tellurium sulph-oxide. If the gas containing hydrogen telluride is passed in for a sufficient time, the red sulph-oxide is destroyed, and a brown substance separates, which sometimes also appears as foliaceous or crystalline black particles of metallic lustre. The destruction of the sulph-oxide can either take place by reduction or by decomposition into sulphuric anhydride and tellurium, the latter forming a per-telluride with the hydrogen telluride. The more probable case of reduction would involve the liberation of sulphurous acid, but as the quantities of the tellurium compounds are relatively very small this gas cannot be detected by its odour. If the gases are passed into solution of permanganate sulphuric acid can be very easily afterwards detected in the liquid. But no sulphurous acid can be shown in this manner so long as the red sulph-oxide is produced during the first action of the hydrogen telluride. Hydrogen telluride has no action upon pure sulphuric acid, at least not immediately, and pure hydrogen has no action upon telluriferous sulphuric acid.

The black-brown precipitate cannot be free tellurium on account of its brown colour, but principally because tellurium is soluble in that state in which it would here have arisen. The precipitate, indeed, re-dissolves in sulphuric acid, but only under certain circumstances. It dissolves quickly with a red colour in sulphuric acid containing tellurium dioxide. It dissolves less readily if fresh sulphuric acid is added to that from which it has been deposited. In this case the sulphuric acid probably exerts an oxidising action, because it contains traces of dissolved oxygen or oxidising agents. It dissolves in the supernatant sulphuric acid, from which it has been precipitated when the mixture is exposed to the air, the re-solution proceeding from the surface of the liquid downwards. Solution occurs also, though more slowly, when the precipitate with the supernatant acid is sealed up in glass tubes filled with hydrogen. Sulphuric acid is then reduced, since on opening the tubes the odour of sulphurous acid is perceptible. This is a fresh proof that the precipitate is not free tellurium, which dissolves without forming sulphurous acid.

These reactions of the brown deposit lead to the conclution that it is a hydrogen per-telluride, the hydrogen of which is quickly oxidised by the air in presence of sulphuric acid, or more slowly by sulphuric acid alone, which is thereby reduced to sulphurous acid.

Not merely hydrogen per-telluride, but the red sulph-oxide is slowly oxidised by sulphuric acid. Sulphuric acid coloured deeply red by tellurium is slowly decolourised, even in sealed tubes. It is a well-known fact that this takes place on the application of heat. If the sealed tubes are opened after their contents have become colourless the odour of sulphurous acid is distinct.

If hydrogen containing hydrogen arsenide, phosphide, or selenide is passed into sulphuric acid in which tellurium sulphate is dissolved the sulphuric acid likewise takes a red colour, and becomes colourless after depositing dark-brown precipitates. In case of hydrogen phosphide the deposit is black.

Selenious acid dissolved in sulphuric acid gives the same reactions as tellurous acid, but less rapidly, and the changes of colour are less striking.—*Berichte der Deutschen Chemischen Gesellschaft.*

SEPARATION OF GALLIUM FROM IRIDIUM.

By M. LECOQ DE BOISBAUDRAN.

THE author indicates four procedures :—

1. The solution containing the iridium in the state of tetrachloride is mixed with from one-fourth to one-third its volume of strong hydrochloric acid, and then with a small excess of potassium ferrocyanide. The precipitate contains the gallium as well as traces of iridium, which are removed by re-dissolving in caustic potassa, acidifying strongly with hydrochloric acid, and treating with ferrocyanide. The operation is repeated twice or thrice.

2. Cupric hydrate precipitates gallium sesquioxide from a hot solution in presence of iridium tetrachloride, but a noteworthy quantity of the latter is found in the galliferous solution after removal of the copper by means of hydrogen sulphide. The iridium may, however, be got rid of by six or seven successive treatments with cupric hydrate.

3. Metallic copper and cuprous oxide may also be used, avoiding too large an excess of the latter. Five or six successive operations are needed to eliminate the iridium.

4. The following method, founded upon certain reactions of iridium recently described (*Comptes Rendus*, May, 1883, pp. 1336, 1406, and 1551) may be recommended:—The chlorides or sulphates of gallium and iridium are mixed with a decided excess of potassium bisulphate. The mass, which must be contained in a vessel of gold, is evaporated, and heated to dull redness. When this temperature is reached the fire is removed. The saline matter is then dissolved in boiling water. The liquid, which is green, blue, or violet, is almost neutralised in the cold with potassa or potassium carbonate. It must, however, remain sufficiently acid to be sensitive to litmus. A large part of the iridium is deposited with the neutral potassium sulphate, which it colours green, whilst almost all the gallium remains in solution. The sediment is washed with water containing neutral potassium sulphate, and very slightly acidulated with sulphuric acid. The collected liquid, almost neutralised with potassa, is boiled in contact with the air from fifteen to thirty minutes. It is then, whilst hot, supersaturated with a slight excess of potassa, and kept nearly at a boil for fifteen to thirty minutes longer. The iridium oxide being collected on a filter, the gallium is extracted from the liquid by the means formerly indicated for its separation from the alkalies. In order to free the iridium oxide from the last traces of gallium it is re-dissolved in dilute sulphuric acid, and re-precipitated, hot, with a slight excess of potassa. This operation may be twice or thrice repeated. The iridiferous potassium sulphate retains little or no gallium. It may, however, be treated in the same manner as the mother-liquor, by solution in water, quasi-neutralisation, boiling with contact of air, and supersaturation with potassa.

It is often useless to effect the separation of the greater part of the iridium in the form of a combination with neutral potassium sulphate. The approximate neutralisation of the original liquid is then effected whilst still hot and sufficiently dilute not to deposit potassium sulphate on filtration.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MAY 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

London, June 5th, 1883.

SIR,—We desire to submit, for the information of the Local Government Board, a statement of the particular and general results of our examination, made at the expense of the Water Companies, of 182 samples of water, collected by us during the past month at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM OLDING,
C. MEYMOTT TIDY.

To the Secretary of the Local Government Board.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from May 1st to May 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination, the whole without exception were clear, bright, and well filtered; and their condition in respect to aëration, and to freedom from colour and excess of organic matter, was unimpeachably excellent.

THE LUMINOSITY OF NON-ILLUMINATING GAS FLAMES.

As the illuminating power of gaseous flames is known to be due to the presence of incandescent solid or even liquid particles, it has been customary to say that the feebly luminous flame of gases which do not contain such particles is the effect of the incandescence of the gas itself at a high temperature. Dr. Werner Siemens had an idea that pure gases, however highly heated, did not emit light; and he has recently carried out a series of experiments to determine this question. In order that an experiment of this

nature should be decisive, the observed temperature should be higher than that produced by luminous combustion. Dr. Werner Siemens therefore had recourse to the regenerative furnace used by his brother Friedrich Siemens, of Dresden, in the manufacture of hard glass. The furnace stands in a separate room, which can be made perfectly dark. In the walls of the furnace are two openings opposite each other, thus allowing free vision through. A heat of 1500° or 2000° C. (or beyond the melting temperature of steel) can easily be obtained. Before the sight-holes were placed a series of smoke-blackened screens, with central openings so proportioned to the holes in the furnace that the observer could look through the latter without receiving any rays from the heated walls. If under these conditions dampers were closed, and all light excluded from the room, it was found that not the least light came to the eye from the highly-heated air in the furnace. For the success of the experiment it was necessary to avoid any combustion in the furnace, and then wait until the enclosed air was as free from dust as possible. Any flame in the furnace—even when not in the line of sight, or the least quantity of dust in it, illuminated the field of vision.

As a result of these experiments, Dr. W. Siemens considers the view hitherto held, that highly-heated gases are self-luminous, is not correct. In the furnace were, in this instance, the products of the previous combustion of the fuel with atmospheric air; or a mixture of oxygen, nitrogen, carbonic acid, and aqueous vapour. If only one of these gases had possessed the property of being self-luminous, the field of vision must have been always illuminated. The weak light of burning gases wherein there is no separation of solid particles cannot, therefore, be considered as a phenomenon of the glow of the gaseous products alone. It further occurred to Dr. W. Siemens as probable that heated gases do not emit heat rays. After again convincing himself and Dr. Herr Fröhlich, of Dresden. that the heated gases were perfectly dark, Dr. W. Siemens's thermopile experiments for the investigation of the other hypothesis failed. By the aid of a common lamp, however, it was found that heated gases do radiate some heat, but much less than some solid bodies at the same temperature. Dr. W. Siemens does not yet say what he believes to be the cause of the feeble light of so-called non-luminous gases.—*Journal of Gas Lighting.*

ON THE

ACTION OF CERTAIN VEGETABLE ACIDS ON LEAD AND TIN.*

(Concluded from p. 291).

By FRANCIS P. HALL.

IT was suggested that the galvanic action would influence more the rapidity of the corrosion than the total amount of metal dissolved; hence that the effect would be more clearly marked at the end of two days than at the end of two weeks, but experiment showed that this is not the case. For this experiment I used only one of the alloys, namely that containing the most tin: the results are recorded in Table II. While the amount of action is not exactly proportional to the time of exposure, it is not far from being so in the case of acetic acid, and in the case of citric and tartaric acids it is evident that the action is very slight at first and increases appreciably as time goes on.

In these experiments, although the metal was covered with the acid and the beaker with a watch-glass, the air had more or less free access to the surface of the liquid. To see what effect the air had on the corrosion, and to approach more nearly the conditions of a sealed can, I took some glass stoppered bottles and repeated the experiment in them. I weighed the strips of metal as before and placed them in the bottles, then heated the bottles on steam cups, and while hot filled them with the acid, also heated to boiling to expel any air. The bottles were at once tightly stoppered. As they cooled a few of them leaked a little, but as it was nearly full of liquid very little air could enter. They were put in the same place as in the former experiments and left for two weeks. On being examined at the end of this time there was evidently much less corrosion than in the case of the corresponding experiments in open beakers. There was no discolouration, and no crystals formed. That the air had been pretty well excluded could be seen from the way the stoppers stuck in the bottles even after they could be turned with ease. The same difference in the character of the precipitates of sulphide of tin was noticed as before.

The results are given in Table III. (See next page.)

It will be noticed that the corrosion was considerably less. For convenience I give a Table showing the comparative results obtained in open and closed vessels.

TABLE IV.

Dissolved from	By Acetic Acid.		By Tartaric Acid.		By Citric Acid.	
	Open.	Closed.	Open.	Closed.	Open.	Closed.
Lead ..	0·4216	0·0886	0·0542	0·0343	0·3521	0·0510
Alloy ..	0·3744	0·0341	0·0298	0·0102	0·1628	0·0267
Tin ..	0·2906	0·0446	0·0212	0·0057	0·1264	0·0134

The acids used were of about the strength of good vinegar. It would naturally be supposed that less strong acids, such as usually occur in canned goods, would cause correspondingly less corrosion. This does not seem to be the case; an incomplete series of experiments seem to indicate that a dilute acid, if used in sufficient quantities, causes much more corrosion than would be inferred from its strength.

To try now the action on the cans themselves, and also the effect of the solder, I took three cans that had been emptied and put 200 c.c. of acid into each—acetic acid in one, tartaric acid in another, and citric acid in the third. I covered these cans as well as I could by tying two thicknesses of paper over each, but of course they were practically open cans; moreover the acid did not nearly fill them. They would represent, therefore, a can that had been partly emptied and sent away, rather than a fresh one. When examined at the end of two weeks, the tinning up as far as the acid reached was entirely taken off, except in the acetic acid. The citric acid had a yellowish colour, and a quantity of white powder was deposited on the bottom of the can. I emptied the acid from the cans and added a few drops of chlorhydric acid, fearing that the organic acid was not sufficient to hold up the sulphide of iron. The addition of chlorhydric acid and a little warming dissolved the white powder in the citric acid, and at the same time destroyed the yellow colour. On passing sulphuretted hydrogen through the solntions, a very large precipitate was obtained. This I filtered off, washed, and treated with ammonium sulphide; the residue was collected on a filter, dissolved in strong chlorhydric acid, and after evaporation the lead was precipitated as sulphate.

The tin was determined in the ammonium sulphide solution. The result was as follows:—

Acetic acid dissolved	0·4178	grm.	of tin	and	0·0117	of lead.
Tartaric ,, ,,	1·0430	,,	,,		0·0873	,,
Citric ,, ,,	0·6828	,,	,,		0·1559	,,

In addition to the lead and tin there was a good deal of iron dissolved.

This shows that corrosion takes place very rapidly after a can is opened, and that a can once opened should be emptied at once. One would have supposed that the acetic acid would have acted more than the others, and it probably would if the conditions in the different cans had been exactly the same. It is probable that more solder was exposed in the cans treated with tartaric and citric

* *American Chemical Journal*, vol. iv., No.6.

TABLE II.

Kind of Acid.	Surface exposed, in sq. inches.		Percentage composition.		Loss of weight, in grms.	Found in solution, in grms.		Percentage of dissolved metals.		Total amount dissolved (in grms.) from	
	Lead.	Tin.	Lead.	Tin.		Lead.	Tin.	Lead.	Tin.	Alloys.	Pure Metals
Acetic ..	7·2	—	100·0	—	0·0515	0·0497	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0460	0·0046	0·0387	10·62	89·38	0·0433	0·0896
,, ..	—	21·6	—	100·0	0·0400	—	0·0399	—	—	—	—
Tartaric ..	7·2	—	100·0	—	0·0400	0·0374	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0120	0·0012	0·0124	8·82	91·82	0·0136	0·0470
,, ..	—	21·6	—	100·0	0·0255	—	0·0096	—	—	—	—
Citric ..	7·2	—	100·0	—	0·0625	0·0599	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0215	0·0015	0·0218	6·44	93·56	0·0233	0·0817
,, ..	—	21·6	—	100·0	0·0120	—	0·0218	—	—	—	—

TABLE III.

Acetic ..	7·2	—	100·0	—	0·0900	0·0886	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0365	0·0052	0·0289	15·25	84·74	0·0341	0·1332
,, ..	—	21·6	—	100·0	0·0430	—	0·0446	—	—	—	—
Tartaric ..	7·2	—	100·0	—	0·0365	0·0343	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0085	0·0018	0·0084	17·65	82·35	0·0102	0·0400
,, ..	—	21·6	—	100·0	0·0080	—	0·0057	—	—	—	—
Citric ..	7·2	—	100·0	—	0·0560	0·0510	—	—	—	—	—
,, ..	7·2	21·6	34·1	65·9	0·0250	0·0018	0·0249	6·74	93·25	0·0267	0·0644
,, ..	—	21·6	—	100·0	0·0120	—	0·0134	—	—	—	—

acids; at any rate the lead must have come from the solder, as the tin from which the cans were made proved, on being tested, to be free from lead.

On the Quality of Commercial Tin-plate.

Having seen the action of some of the more common vegetable acids on lead and tin, and the alloys of the same, we come to the tin-plate itself.

The tin plate used in America is entirely imported, most of it from England. The two principal kinds are "Bright plate" and "Terne plate." Bright plate is, or should be, tinned only with pure tin. It is divided into several grades, according to the thickness of the tinning and the quality and heaviness of the iron which forms the basis, but in all these grades the tinning is supposed to be pure tin. Terne plate, on the other hand, is known to contain large quantities of lead, and is often called lead-plate, there being no attempt to pass it for tin, at least by respectable persons.

Tinware and fruit-cans are made from bright plate, while terne plate is used altogether for roofing. Of course the boundaries are sometimes overstepped; those who are very particular use bright plate for roofing, and those who are too avaricious may make tin-ware out of terne plate. This last, I think, however, is very seldom the case, and the heavy nature of terne plate unfits it for canning.

Knowing these divisions of tin-plate, the questions before us now are: Is bright plate, especially that used in canning, always tinned with pure tin? and how commonly is terne plate used where it will come in contact with food.

I procured some specimens of plate through the kindness of one of the largest importing houses in the city. These I tested by several methods. With the bright plate, taking small pieces, I could find no lead at all, and only after taking half a square foot did I find a trace. This was no more than would be found in most English bar-tin. I now tested a number of cans from various sources, as well as the worst-looking tinware from the so-called 5-cent stores, but not once did I find enough lead to show an intentional adulteration. Neither have I found any well instituted attack on the character of the tin-plate in this country. A good deal has been said and many suspicions thrown out, but the only statements of analyses that I have seen are in a Board of Health report of a Western State.* The author found lead so invariably in all tin articles that came into his hands that one cannot help suspecting that the methods of analysis were unreliable. He even observes that he found a considerable quantity of lead in what was sold for pure tin—a thing quite possible, it is true, but not likely to happen with dealers to whom a chemist would naturally go for pure supplies.

Even if the tin of the can is pure, there remains the solder, which always contains a large quantity of lead, and is used very freely. There remains, also, the fact that the vegetable acids act considerably upon tin itself. There are many published statements as to the presence of tin in canned goods, and the careful inspection of the inside of a can which has contained an acid fruit shows quite clearly in many cases that corrosion has taken place. Moreover, although my experiments tend to show that the amonnt dissolved when the air is excluded is much less than when open, still it is an appreciable quantity; and if, as seems to be the case, the amount increases with the time, that dissolved from an old can must be considerable.†

The terne plate, which is that most often used for roofing, cannot be considered quite harmless in cases where the water from the roof is used for household purposes. But as the tin roof as well as the whole house is generally covered with a paint containing far more lead than the terne plate itself, it would be absurd to complain while we use white-lead to such an extent as at present.

I made a rough analysis of the tinning of terne plate by dissolving it off with chlorhydric acid, precipitating the lead and tin as sulphide and separating them with sulphide of ammonium. The result was as follows:—One-fifth of a square foot gave 1·1650 grm. of lead and 0·4469 grm. of tin, which would make the tinning consist of 72·27 per cent of lead and 27·73 per cent of tin. Terne plate can be readily told by its dulness; it comes also in larger sheets than bright plate.

Although constantly on the watch for tinware made of terne plate, I have been able to find none. I am informed on good authority, however, that it is sometimes used for that purpose, but conclude that such use must be rare in this section of the country.

* "Mich. Board of Health Report," 1878, p. 29.

† It is hardly to be supposed that the proportion indicated by the above experiments continues indefinitely.

TABLE V.

No.	Amount taken. Size in sq. in.	Amount taken. Weight in grms.	Amount found, in grms. Tin.	Amount found, in grms. Lead.	Percentage. Tin.	Percentage. Lead.
1.	6	0·2285	0·2275	—	99·53	—
2.	6	0·4260	0·4227	—	99·23	—
3.	6	0·5950	0·5929	—	99·65	—
4.	6	0·5150	0·1162	0·3945	22·56	76·60
5.	6	0·9080	0.0902	0·8152	9·94	89·95
6.	6	0·7140	0·1642	0·5464	23·00	76·41
7.	6	2·0785	0·0839	1·9860	3·86	95·75
8.	6	1·8580	0·1172	1·7360	6·31	93·43
9.	6	0·3030	0·1125	0·1819	37·44	60·03
10.	2·25	0·4720	0·1078	0·3678	22·84	77·94
11.	3	0·8005	0·2004	0·5969	25·03	74·55
12.	6	1·4940	—	1·2240	—	81·92

TABLE VI.

21.	6	0·2650	0·2653	—	100·10	—
22.	6	0·5145	0·5130	—	99·70	—
23.	6	0·2560	0·2559	—	99·96	—
24.	6	1·1175	0·1111	1·0040	9·94	89·87
25.	—	1·1600	0·2570	0·8733	22·15	75·27
26.	—	0·7915	0·1645	0·5793	20·77	73·19
27.	6	0·4435	0·4419	—	99·63	—
28.	2	0·4850	0·0338	0.3879	19·34	79·99

On Commercial Tin-foil.

Tin-foil is so much used now-a-days on chocolate, compressed yeast, cheese, and the like, that I thought the analysis of a few samples might not be amiss. Here at the outset we have a good proof of adulteration, from the fact that the price of most foil is but little more than half the price of pure bar tin.

I collected a number of samples from different importers and manufacturers. They varied greatly in thickness, colouring, and design, but I had reason to suppose that many were the same in composition. I took what I thought was a fair sample of them as regarded composition, and analysed them.

The method used was that usually used for solders, the oxidation with nitric acid. It was not thought necessary to correct for the trace of lead retained by the oxide of tin; neither were traces of copper or other metals sought for, which even if present would hardy influence the character of the foil, at least as far as sanitary purposes were concerned. The results of the analyses will be found in Table V. I give in the table the size of the piece of foil taken for analysis, its weight, and the weight of the lead and tin found in it, as well as the percentage composition. Only the first three foils were sold for pure tin. Some were sold as "composition foils," but generally, unless special inquiry was made, nothing was said of their composition.

In order to see if I had had a fair sample of the foils in general use, and to see which of them were most used on articles of food, I took several foils that had been in actual use and analysed them. The results appear in Table VI. It will be seen that each corresponds very nearly to some one in Table V. Nos. 21, 23, and 28 were on chocolate; Nos. 22 and 27 on different kinds of compressed yeast; Nos. 25 and 26 on "Neuchâtel" cheese; No. 24 on the outside of a box of troches. No. 23 was on a small cake of chocolate bought at a street stand, while No. 28 was an embossed foil and on a very fashionable cake of chocolate. No. 25 was very brittle and showed signs of being acted upon. The cheese was quite acid to litmus.*

Mass. Inst. of Technology, Boston, Mass.

* The use of a foil containing about 75 per cent of lead for wrapping the so-called Neuchatel and other soft cheese is certainly reprehensible. Owing to the acid in, or developed in, the cheese the foil becomes crumbly, and even when the cheese is first covered with greased paper, particles of the oxidised foil are very likely to become attached to the cheese as it is used. Attention has been repeatedly called to this matter abroad, among others by Wittstein (*Dingler's Polyt. Journ.*, 208, p. 341), who found appreciable amounts of lead in cheese thus wrapped.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 21, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

A BALLOT was held, and the Scrutators, Dr. Thorne and Mr. Meldola, declared the following gentlemen duly elected Fellows of the Society:—G. S. Bowler, C. Beringer, T. H. Coleman, A. Esilman, H. E. Harrison, C. Hulke, H. Heap, B. Hobbs, C. T. Heycock, W. J. Livingston, B. P. Lascelles, H. R. Mill, M. F. Purcell, J. E. Richardson, F. G. Roberts, W. R. Reffell, A. Smith, E. H. B. Stephenson, A. W. Soward, A. H. Samuel, D. Wilson, R. Williams.

The PRESIDENT then called on Prof. MCLEOD to read a paper "*On Evaporation in Vacuo.*"

The ordinary method of evaporation *in vacuo* over sulphuric acid is very slow, for three reasons:—The aqueous vapour reaches the surface of the acid by diffusion only; the surface of the sulphuric acid is limited, and as the dilute sulphuric floats on the concentrated acid, the absorption of aqueous vapour is much retarded; lastly, heat is supplied but slowly to the evaporating liquid, being almost entirely that reaching it by radiation. In one experiment 50 c.c. of water placed *in vacuo* over 250 c.c. of sulphuric acid required two-and-a-quarter days for complete evaporation. The author was led to try some experiments on the evaporation of water at low temperatures by some remarks of Prof. Mallet (CHEMICAL NEWS, vol. xlvi., 62, 73, &c.), and the method was suggested by Wright's apparatus for the distillation of mercury (*Ibid.*, xliv., 311). A somewhat similar apparatus is described by Mallet (*Ibid.*, xlvii., 218, 252). The author used a Körting's

jet-pump to produce the vacuum. In one form of apparatus the water was evaporated in a glass dish with ground top, which pressed a red india-rubber ring against a brass ring soldered to a copper dome. The aqueous vapour was condensed in a copper vessel consisting of a truncated cone within a cylinder. The tube by which the water to be evaporated is supplied ends in a small glass funnel, the mouth of which touches the inside of the dish. The dish is surrounded by a water-bath at 50°. The temperature of the water in the dish was found to be 26°: 50 c.c. of water can be evaporated in two hours. Instead of the dish the author has used a wide test-tube, or a combustion-tube, so that the water residue can be evaporated in the tube afterwards used for effecting its combustion. In another modification described by the author the condenser is replaced by a wide vertical tube, down the inner surface of which a thin layer of sulphuric acid is allowed to flow. The aqueous vapour is thus rapidly absorbed, and passes down the fall-tube as dilute sulphuric acid. It is necessary to cool the sulphuric acid by a flow of cold water. The author exhibited this apparatus at work, and incidentally described a useful valve for preventing the loss of a vacuum, which occurs when using Körting's pump, if the water pressure be suddenly diminished. The stream of water passes down a narrow glass tube into an elongated bulb, from the bottom of which it issues by a T-piece. In this bulb floats a piece of glass tube filled with air and closed at both ends, so that it just floats in water. The upper end of this float is ground, so that if the water stream stops the float rises and stoppers up the narrow glass tube: the vacuum is thus preserved.

Mr. THORP said the paper was of great interest to water analysts. He was afraid that it might be difficult to mix the water residue in the combustion tube perfectly with oxide of copper, and there seemed to him a possibility of the introduction of small pieces of india-rubber.

Dr. ROSCOE then communicated a paper "*On the Preparation of the Pentathionates*," by S. SHAW. Professor Spring (*Annalen*, 213 [3], 329) expresses doubts as to the existence of pentathionic acid and the pentathionates, and especially combats the statements of Lewes (*Chem. Soc. Jour.*, March, 1881), who prepared and analysed the potassium and barium salts. The author therefore repeated Lewes's work, and has been able to confirm completely his results. He has succeeded in preparing perfectly clear transparent crystals of potassium pentathionate, which can be re-crystallised, which differ in form from the tetrathionate, and give a white precipitate of sulphur when treated with caustic potash. On analysis they were proved to contain 2 atoms of potassium to 5 of sulphur.

Appended to this paper is a "*Note on Pentathionic Acid*," by WATSON SMITH. In it it is proved that Wackenroder solution prepared with excess of sulphur dioxide does not bleach dilute indigo solutions. When to half-neutralised Wackenroder solution caustic potash is added no precipitate is produced, because in the presence of free sulphurous acid thiosulphate is formed. If, however, the solution be evaporated the sulphur dioxide is expelled, and the sulphites and thio sulphates are decomposed. A liquid is then obtained, which gives with caustic potash a precipitate of sulphur from the decomposition of the pentathionates.

Dr. DEBUS said that Mr. Lewes was still working at the subject, and had obtained crystals of potassium pentathionate more than an inch in length. The pentathionates could only be prepared and re-crystallised from acid solutions. If one-half of a solution was neutralised and the other half added the pentathionates were decomposed. The quantity of base required must be calculated, and then added to the acid solution.

Dr. ARMSTRONG then read a "*Note on Hydrocarbons from Camphor.*" The author in a previous communication (December, 1877) announced that he was engaged in an examination of the mixture of hydrocarbons produced by the action of several of the so-called dehydrating agents on camphor. Owing to the complex character of the product the time occupied in fractional distillation, &c., but little progress had been made in the research. During the last few months, however, the author has, in conjunction with Dr. Miller, repeated the whole of the previous work on a very large scale, and satisfactory methods of separation have been devised, so that it will soon be possible to publish a complete account of the investigation. An exhaustive study has been made of the actions of phosphoric anhydride, phosphorus penta-sulphide, zinc chloride, and of iodine. The author gave some account of the action with zinc chloride. After describing the method of operating and separating the products, he stated that in the main C_{10} compounds are produced under the conditions which have been maintained in carrying out the reaction. The phenol produced is carvacrol, and the chief constituents of the hydrocarbon mixture are $C_{10}H_{20}$ and two $C_{10}H_{14}$ hydrocarbons; relatively small quantities of both higher and lower homologues of $C_{10}H_{14}$ are also present, together with one or two hydrocarbons, which are carbonised by sulphuric acid, and are not yet satisfactorily identified. The two $C_{10}H_{14}$ hydrocarbons are isomers of cymene; the barium salt of one of these is almost insoluble in water, the sodium salt crystallising with one molecule of water in large nacreous plates. The barium sulpho-salt of the other hydrocarbon is easily soluble and closely resembles ordinary barium cymene sulphonate, with which previous observers have identified it. For a long time the author of the present note was similarly mistaken. The salt, however, contains $3\frac{1}{2}$ molecules of water of crystallisation, and is convertible into a magnesium salt, which is highly characteristic, and is altogether different from ordinary magnesium cymene sulphonate. Although two other easily soluble barium sulpho-salts, derived from $C_{10}H_{14}$ hydrocarbons, have been isolated, one crystallising with 9 molecules of water in long flat prisms, the other with $7\frac{1}{2}$ molecules in small glistening plates, no indication of the presence of ordinary cymene in the product from the action of zinc chloride has been obtained. A not inconsiderable quantity of camphorene, $C_9H_{12}O$, is also produced. The product of the action of iodine on camphor does not contain cymene, but yields the sulpho-salt resembling that of ordinary cymene referred to above.

In answer to Dr. TILDEN,

Dr. ARMSTRONG said that he was quite satisfied that the hydrocarbons were $C_{10}H_{14}$, and not $C_{10}H_{16}$ hydrocarbons.

Mr. V. H. VELEY then read a paper "*On the Rate of the Decomposition of Ammonium Nitrate.*" The author has carefully measured the rate at which gas is evolved by heating pure ammonium nitrate at a constant temperature. He has arrived at the following conclusions:—That the rate of decomposition into nitrous oxide and water is dependent, not only on the mass of the salt, but on the proportion of free nitric acid present. If the reaction of the salt be rendered alkaline, the rate gradually increases as the proportion of free acid increases; a period of maximum velocity is then reached corresponding to the greatest proportion of free acid; the rate then slowly decreases with the decrease of free acid. An excess of ammonia completely stops the reaction, even when the temperature is raised 50° or 60° above the normal temperature of decomposition. If the reaction of the salt be rendered acid at starting, the rate of decomposition gradually decreases as the acid decreases. After heating the salt for thirteen to sixteen hours, the rate of change becomes practically constant. The apparatus used in the research was exhibited, and the method illustrated before the Meeting by the author.

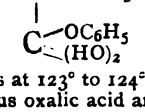
Prof. RAMSAY then shortly described and exhibited a new gas burner for heating combustion tubes. The burner consists of a Bunsen burner, on the top of which fits a brass T-piece. The top of the T is about 6 inches long and 1 inch in diameter. It has a longitudinal slit cut in it on the top. The ends are closed by pieces of sheet-brass, which are arranged so that they support the tube to be

heated. By a simple arrangement any third of the slit can be closed or opened. A series of these tubes can be connected together by a bayonet catch, so that any length of tube can be supported and heated. The tube is covered by a length of asbestos cardboard. The principal advantages are that the arrangement is cheap and cools quickly, so that seven combustions can be performed in a day.

The two following papers were taken as read :—

"*Note on the Action of Allylic Iodide upon Phenol in the Presence of Zinc or Aluminium Foil*," by P. T. FRANKLAND and T. TURNER. A colourless liquid was obtained, boiling at 223° to 225°. It proved to be ortho-propylphenol.

"*On a By-product of the Manufacture of Aurin*," by A. CLAPAREDE and WATSON SMITH. When aurin is prepared from phenol, oxalic acid, and sulphuric acid, a quantity of white crystals are found on the lids of the aurin pots. The authors have purified and analysed these crystals, which consist of a phenyl-ortho-oxalic ether,—



This substance melts at 123° to 124°. It is formed when phenol and anhydrous oxalic acid are distilled together.

The Society then adjourned over the summer recess.

PHYSICAL SOCIETY.

Saturday, June 23rd, 1883.

Prof. CLIFTON, President, in the Chair.

NEW Member— Mr. Stearn.

Prof. D. E. HUGHES, F.R.S., exhibited a number of experiments illustrating his theory that a magnet is made up of magnetic molecules, each of which is a small magnet. When a magnetic metal is in a neutral state, he showed that there is a symmetrical arrangement of the molecules, such as to make them satisfy their mutual attractions ; not, as on Ampère's theory, a "higgledy-piggledy" arrangement.

Prof. GUTHRIE stated that a piece of watch spring magnetised retains its magnetism when impregnated with mercury. He also illustrated the distinction between "higgledy" and "piggledy."

Prof. EVERETT, Mr. W. H. COFFIN, and others, remarked that Ampère's theory tried to account for the magnetism of the molecules.

Profs. PERRY and AYRTON stated that when soft iron is between red- and white-hot, it ceases to be attracted by a magnet.

The new Absolute Sine-Galvanometer of Prof. Minchin was then exhibited to the meeting by Prof. G. CAREY FOSTER. It is intended for the Cornell University, and measures less than the E.M.F. of a Daniell cell. The principle of the instrument was described at a former meeting of the Society.

Prof. AYRTON, Lord RAYLEIGH, Mr. COFFIN, and Prof. CLIFTON offered some remarks on the apparatus.

A "*Note on the Induction Balance Effect, and the Densities of Alloys of Copper and Antimony*," by Mr. GEORGE KAMENSKY, A.R.S.M., was then explained by Prof. CHANDLER ROBERTS. These experiments were to determine whether the curve of the electrical resistance of the copper-antimony alloys would be a straight horizontal line, U-shaped, or of the L type. It was found to belong to the last type. It is seen from the curve exhibited that there is a rapid fall from copper to the alloy containing only 10 per cent antimony, and this decrement is continued until the alloy $SbCu_4$ is reached, when the curve turns rapidly and rises to $SbCu_2$, then turns again and passes to pure antimony. Prof. Roberts has shown that the alloy $SnCu_4$ occupies the low est poin of the curve, namely, the position that in the copper-antimony series is occupied by the alloy $SbCu_4$. In the copper-tin series the second critical point is held by $SnCu_3$, and in the copper-antimony curve this point is held not by Cu_3Sb, but Cu_2Sb, the formula for the violet alloy known to alchemists as the "regulus of Venus." The specific gravities were also plotted in curves, showing that the alloy Cu_2Sb does not stand out from the rest, while the alloy Cu_4Sb has a higher density than copper.

OBITUARY.

DEATH OF MR. SPOTTISWOODE.

WE regret to announce the death of Mr. Spottiswoode. LL.D., President of the Royal Society, which took place on Wednesday morning last at a quarter past eleven o'clock.

Mr. Spottiswoode was born in January, 1825, and was consequently in his fifty-ninth year. He was educated at Dr. Buckland's school at Laleham, and afterwards at Eton, and at Harrow under Dr. Wordsworth. He entered Balliol College, Oxford, in 1842, graduated B.A. as a first-class in mathematics in 1845, and gained university mathematical scholarships in 1846 and 1847. On leaving Oxford he took the management of the business of the Queen's printer, but he continued his studies in mathematics, philosophy, and languages ; was elected a Fellow of the Astronomical, Royal, Geographical, Asiatic, and Ethnological Societies, and of the Society of Arts. In 1857-58, Mr. Spottiswoode was Public Examiner in Mathematics at Oxford, and he has acted as examiner under the Civil Service Commission, for the Society of Arts, and for the Middle Class Schools. He was appointed Treasurer of the Royal Society in 1871, and was elected President in 1878. He was also elected President of the British Association in the same year, at the Dublin meeting, when the University of Dublin conferred on him the honorary degree of LL.D. A similar degree had in 1871 been conferred on him by the Edinburgh University.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 23, June 4, 1883.

The Solubility of Copper Sulphide in the Alkaline Sulpho-molybdates.—M. Debray.—The product of the action of sulphuric acid upon cerite, re-dissolved in water, gives a liquid which is more or less abundantly precipitated by hydrogen sulphide. The blackish precipitate contains copper, lead, bismuth, and tungsten, and also molybdenum,—a fact of little importance if the detection of molybenum in presence of copper did not present an interesting singularity. On digesting the well-washed precipitate of sulphide with ammonium sulphide there is produced a deep-brown liquid, from which dilute hydrochloric acid precipitates a reddish body, which filters badly. If this precipitate is roasted at a low temperature, it yields a brown substance, which melts at a red heat, and crystallises on cooling like vanadic acid, but which is copper molybdate. On melting it with dry sodium carbonate and re-dissolving in water, there is obtained a black residue of copper oxide and soluble sodium molybdate. This compound, if produced by double decompo-

sition is very easily fusible at redness, with disengagement of oxygen, because a certain quantity of cuprous molybdate is produced. Copper sulphide may also be dissolved in an alkaline sulpho-molybdate, which, on the addition of hydrochloric acid, gives the reddish precipitate above mentioned. The quantity of sulphide which may thus be dissolved in the alkaline sulpho-molybdates is very considerable, corresponding to the formation of a definite copper sulpho-molybdate.

An Apparatus for Obtaining Low Temperatures Capable of being Regulated at Will.—P. Gibier.—This paper requires the two accompanying diagrams.

Phosphorus Sub-sulphides.—M. Isambert.—The author has repeated the experiments of Berzelius and Dupré on the lower sulphides of phosphorus. He agrees with these chemists as to the facts observed, but considers that their interpretation must be completely modified. He finds that phosphorus is a solvent for sulphur and phosphorus sulphide, P_2S_3, which remains liquid even below its melting-point. Ordinary phosphorus is rapidly converted into red phosphorus if heated in presence of a small quantity of phosphorus sesquisulphide.

Phosphorus Sesqui-sulphide.—G. Lemoine.—The author, referring to the paper of M. Isambert's, inserted in the *Comptes Rendus* of May 21, 1883, calls attention to the fact that most of the experiments therein described had been already published by him in the *Comptes Rendus*, May 16, 1864, and in his "Theses for the Doctorate of the Faculty of Sciences of Paris," June 15, 1865, from which he makes quotations.

Freezing-point of Acid Solutions.—F. M. Raoult.—The author gives tables of the lowering of the freezing-point occasioned by adding 1 grm. of various acids to 100 grms. of water. He has established that the sulphurous, iodic, phosphorous, arsenious, and arsenic acids are almost entirely expelled from their alkaline salts in dilute solutions by a quantity of hydrochloric or nitric acid sufficient to saturate the base.

Thermic Study on the Solution of Hydrofluoric Acid in Water.—M. Guntz.—The author examines the solution-heat of gaseous and of liquid hydrofluoric acid, the volatilisation-heat of liquid hydrofluoric acid, and the dilution-heat of the same acid in different states of concentration.

Transformation of Glycolide into Glycolic Acid.—M. de Forcrand.—A thermo-chemical study. The transformation is exothermic, setting out from liquid water, but endothermic if we set out with solid water.

Researches on the Production of Crystalline Borates by the Moist Way.—A. Ditte.—The author has succeeded in obtaining several groups of well-crystallised borates, a description of which will appear on a future occasion.

Reactions of Lead Sulphide upon the Metallic Chlorides.—A. Levallois.—The author has experimented with the chlorides of magnesium, aluminium, zinc, silver, antimony, and gold, ferric, mercuric, stannous, stannic, and platinic chlorides. All these compounds react rapidly upon lead sulphide. Even magnesium chloride, in the absence of any trace of free hydrochloric acid yields needles of lead chloride.

Baking of Plaster.—H. Le Chatellier.—The author studies the various hydrates of gypsum and their tensions of dissociation.

An Acid obtained by the Oxidation of Strychnine.—M. Hanriot.—The acid is obtained by treating a neutral solution of a salt of strychnine with permanganate, added carefully in small successive quantities. The composition of the acid is represented by $C_{11}H_{11}NO_3,H_2O$. It is soluble in alcohol, but insoluble in water and ether. It dissolves readily in alkaline and acid solutions.

Bulletin de la Société Chimique de Paris.
No. 11, June 5, 1883.

Mono-nitroso-resorcine.—A. Févre.—The author obtains the sodium salt of this new compound by dissolving resorcine in 5 to 10 times its weight of alcohol, adding to the solution soda lye enough to form an acid sodium salt, refrigerating strongly, and stirring all the time. He then pours in gradually amyl-nitrite in the proportion of 1 mol. to 1 mol. resorcine. The acid salt of sodium monitroso-resorcine is after some time deposited as a granular brick-red precipitate.

Russian Chemical Society.—Session October 7/19, 1882.—M. Lubavine communicated the results of the analysis of the phosphorites of Ardatoff, near Nijni-Novgorod.

M. Kutcheroff has studied the action of the hydrocarbides of the acetylenic series, and in particular that of allylene upon mercuric salts. On agitating aqueous solutions of mercuric salts with allylene, there are obtained white precipitates, compact and sometimes crystalline.

M. Pavloff communicated the result of an analysis of the mineral waters of Druskeniki.

M. Moltchanowsky sent in a memoir on the preparation of azoxy-benzide by Klinger's process.

M. Samonoff contributed a paper on azoxylol.

Journal de Pharmacie et de Chemie.
Tome vii., May, 1883.

Copper and Lead in Food and in the Arts from a Hygienic Point of View.—A. Gautier.—The author shows that copper is little calculated to produce mortal results. The solubility of most of its salts, their marked colour, nauseating taste, and emetic action give at once warning. The salts of lead, on the contrary, have no pronounced taste, or are even sweetish. They are in general colourless. If introduced into the system there is no alarming effect until the nervous centres, the liver, and the blood have become interpenetrated with the poison. All foods sold in tins, especially if of a fatty nature, public water-supplies, wines, beers, effervescing drinks, the glaze of earthenware, enamels, and especially culinary utensils lined with tin, may introduce lead into the system. M. Gautier calculates that every Parisian absorbs daily ½ m.grm. of lead salts.

Journal für Praktische Chemie.
New Series, Vol. xxvii., Parts 6 and 7.

Nitrogenous Derivatives of Meconic Acid, and their Conversion into Pyridine (Second treatise).—H. Ost.—In this extensive treatise the author describes, among the derivatives of pyrone, pyromekazonic acid, brom-pyromekazonic acid, diacetyl-pyromekazonic acid, nitro-pyromekazon, nitro-pyromekazonic acid, pyromekazon-hydrate, oxy-komenaminic acid, brom-oxy-komenaminic acid, azon-carbonic acid, komenaminic acid, pyro-komenaminic acid. In his study of the derivatives of pyridine the author examines the action of phosphorus pentachloride upon komenaminic dihydro-oxypyridin-carbonic acid, hexachlor-picoline and pentachlor-picoline, monochlor-α-picoline, chloriodo-picoline, dichlorpyridin-carbonic acid, tetrahydro-monochlor-picolic acid, monochlor-picolic acid, hexahydro-picolic acid, the α- and β-oxy-picolic acids, dichlor-α-oxy-picolic acid, and monochlor-β-oxy-picolic acid. He, lastly, studies the action of phosphorus pentachloride upon komenic acid.

Amarine and Furfurine.—Dr. R. Bahrmann.—The author has examined the behaviour of amarine with acetyl chloride, benzoyl chloride, and chloro-carbonic ether. The principal results are that by the action of acid chlorides upon amarine in ethereal solution there occurs a simple addition of the reacting substances, molecular compounds

of feeble stability being formed. From an alcoholic solution of acetyl-chloride-amarine there separates out indifferent diacetyl-amarine. Benzoyl-chloride with amarine in alcoholic solution yields oxethyl-benzoyl-amarine. Chloro-carbonic ether with amarine in alcoholic solution, is transformed into dicarboxethyl-amarine, which, if heated with ammonia in alcoholic solution, is changed into the base dicarboxethyl-amidamarine. The author also examines the behaviour of furfurine with acetyl-chloride, benzoyl-chloride, and chloro-carbonic acid. It appears that furfurine, like amarine, forms, with acid chlorides, molecular unstable compounds, but only one atom of hydrogen can be readily substituted by acid radicles.

Antimon-trisulphide in Aqueous Solution.—In a former memoir the author has shown that like the hydrates of ferric oxide, alumina, and silica, arsen-trisulphide may occur not merely in the ordinary insoluble state, but also in a soluble form. This soluble arsen-trisulphide is readily obtained by passing hydrogen sulphide into an aqueous solution of arsenious acid free from foreign matters. The attempt to obtain in an analogous manner a colloid, soluble antimony-trisulphide was successful, but not quite satisfactory, as the solution contained only a very small quantity of the sulphide. The author refers to the fact that solutions of tartar emetic, on treatment with hydrogen sulphide, often do not form a precipitate, but merely take a deep red colour. On adding an indifferent salt, such as magnesium sulphate, the trisulphide is at once deposited in its usual state. Concentrated solutions of antimony-tersulphide are completely precipitated by hydrogen sulphide; in more dilute solutions the precipitation is less perfect and slower, and if there is only 1 part of the salt in 200 of water, there is no precipitation at all, and the liquid takes a deep red colour. No foreign matter must be present. Antimony trisulphide appears always at first as a colloidal soluble modification; its precipitation in the insoluble form is a secondary phenomenon. The author considers that it will be found practicable to obtain other inorganic bodies, known at present only in the insoluble form, in a soluble colloid condition.

Vol. xxvii., Nos. 8 and 9.

Phenyl-amido-Propionic Acid, Amido-valerianic Acid, and certain other Nitrogenous Constituents of Seedling Lupins (*Lupinus Luteus*).—E. Schulze and J. Barbieri.—The axial organs of seedling lupins two or three weeks after germination contain very much asparagin, not inconsiderable quantities of phenyl-amido-propionic acid, and amido-valerianic acid. Leucin and tyrosin are probably present, but only in very small quantities, and could not be recognised with certainty. The cotyledons contain much less asparagin than the axial organs, but this substance is still present in notable quantity after the germination has continued for two or three weeks. Amidic acids (principally leucins?) were found in the axial organs as well as in the cotyledons. Lecithin has been found in the former, and is probably not absent in the cotyledons. Peptones are found in different parts of the seedlings, but only in very small quantity.

Researches from the Chemical Laboratory of Prof. A. Saytzeff, at Kasan.—These investigations consist of a preliminary communication on the refractive power of organic compounds in solution, by J. Kanownikoff; on a by-product obtained during the preparation of allyl-dimethyl-carbinol, by W. Dief; on a hydro-carbinol obtained from ally-dimethyl-carbinol, by W. Nikolsky and Al. Saytzeff; and researches on another hydrocarbon obtained from the same source, by S. Reformatsky.

Chemico-critical Passages.—H. Kolbe.—A critique of E. Fischer's recent memoir on "Caffeine, Theobromine, Xanthine, and Guanine."

Action of Phthalic Anhydride upon the Amido-acids.—E. Drechsel.—A preliminary communication. The author, on heating phthalic anhydride with glycocoll, obtains, not uric acid, as he expected, but a new compound which he names phthalyl-glycocoll, or phthaluric acid.

Brief Communications.—E. Drechsel.—These comprise a method for experimenting in sealed tubes upon the small scale. He takes a glass tube of 3 to 4 m.m. internal diameter and 1 m.m. or more thick. The tube is melted up at one end, charged, and drawn out at the other end to a long but thick sided capillary. The tube itself is from 5 to 6 c.m., and the capillary from 10 to 15 c.m. In order to apply heat the complete tube is placed in a wide and long test-tube, and is secured by means of a loosely-fitting perforated cork, so that the lower end remains at the distance of 1 to 1·5 c.m. from the bottom of the test-tube. Into the latter is then poured a liquid, selected according to the temperature to be reached, in such a quantity that the sealed tube plunges into it to half its length. Heat is then applied, regulating the flame so that the whole of the sealed tube and a part of the capillary end may be bathed in the vapour without, however, reaching the cork.—A second communication by the same author recommends the use of phosphoric instead of sulphuric acid in Pettenkofer's reaction for the biliary acids. The solid in question, *e.g.*, a granule sodium cholalate, along with a trace of cane-sugar, is dissolved in 1 to 3 drops of a mixture of 5 vols. of commercial syrupy phosphoric acid and 1 vol. of water. The whole is heated by plunging the vessel in boiling water, when the red colouration quickly appears if a biliary acid is present.

Simple Preparation of Phenetol.—H. Kolbe.—Crude sulph-etheric acid, obtained by quickly mixing equal volumes of concentrated sulphuric acid and strong alcohol, is, when cold, diluted with water, neutralised with soda until it has an alkaline reaction, and the solution is evaporated over an open fire, until abundance of sodium sulphate has crystallised out. The warm mother-liquor is mixed with a thick solution of phenol sodium, and the whole is heated in an autoclave for some hours to the temperature of 150° under a pressure of 7 atmospheres. The solution of phenol sodium is obtained by mixing the calculated quantity of phenol and soda-lye at sp. gr. 1·33. In calculating the required quantity of phenol and sulph-etheric salt, we proceed on the assumption that half the alcohol employed is recovered as sodium sulph-etherate. On opening the autoclave the phenetol is found floating upon the semi-solid saline mixture. It is drawn off, shaken with water, and rectified. In a corresponding manner may be obtained anisol, and doubtless nitranisol and nitro-phenetol, by means of nitro-phenol sodium.

The Ptomaines: Chemical, Physiological, and Chemico-forensic Investigations.—J. Guareschi and A. Mosso.—The first portion of an extensive treatise.

Moniteur Scientifique, Quesneville.
June, 1883.

Industrial Society of Mulhouse, Chemical Section.—Session of March 21st.—M. Schatz sent in a memoir on the part played by oiling in Turkey red dyeing.

M. Poirrier, of Cholet, writes that he is the inventor of a fast grey, but he indicates neither its properties nor the method of its application.

An English memoir on improvements in bleaching wool and silk, sent in competition for the prize No. VI., was referred to M. Noelting for examination.

M. Witz read a very interesting memoir on the disorganisation of vegetable fibre by a salt of copper, which had been exposed to the sun and then to an alkaline treatment. This kind of alteration is similar to that observed by M. Jeanmaire with chromic acid.

M. Louis Durand gave an account of an American patent taken out April 27, 1881, by Armand Müller-Jacobs, of Moscow, concerning the manufacture of the sulpholeates, and consisting in the reaction of sulphuric acid upon fatty matters in general, followed by the addition of an alkali

to neutralise the product. It was remarked that the preparation and the use of this compound were described by Runge in his "Farben-chemie," published in 1834.

M. Camille Kœchlin presented specimens of a green obtained on tissues with copper phosphate. He prints the following colour :—Water, 3 litres; ammonia, 1 litre; crystalline copper acetate, 400 grms ; and sodium phosphate, 800 grms. Dry, air for some hours, wash, and soap at 60°. Sodium phosphite gives a colour parallel to the phosphate; the hypo-phosphite is greener.

M. Schæffer utilises the properties of hydroxylamine for producing discharges on manganese bronzes. Its price is at present too high for practical purposes.

Discussion at the Academy of Medicine on Typhoid Fever and Microbia.—This discussion has a purely medical interest.

Conference on New Explosives.—M. Trauzl.—An account of the properties of nitroglycerin, gun-cotton, and the solution of the latter in the former, which bears the misleading names of Nobel's gelatine, explosive gelatine, or dynamite gelatine.

List of Foreign Patents.—The abridged specifications of a number of patents taken out in Germany and in England, and compiled from various journals.

Manufacture and Decoration of Porcelain.—Charles Lauth.—A paper read before the Société d'Encouragement.

Production of the Sèvres Blue on Porcelain.—C. Lauth.—Already noticed.

Utilisation of the Volatile Products of Coal.—M. Jameson.—From the *Journal of the Society of Chemical Industry*.

Carbonate of Soda as a Residue.—L. Faucheux.—The author speaks of an improvement in the alkali manufacture which he has devised. He uses as raw materials salt-cake and coal, and obtains as products caustic soda, carbonate of soda, and pure sulphur. He has no refuse to remove, and the plant of a Leblanc works will require but little alteration. He gives, however, no particulars.

The Iron and Steel Industry.—A. Jouglet.—The author speaks in general terms of the improvements of Bessemer and Siemens, and of a secret process by which 22 tons of iron can be obtained from the ore in fourteen minutes.

New Process for the Determination of Urea.—L. Hugounenq.—Already noticed.

Review of Foreign Chemical Researches.—G. de Bechi.—Extracts from the CHEMICAL NEWS, the *Journal of the Chemical Society*, and the Berlin *Berichte*.

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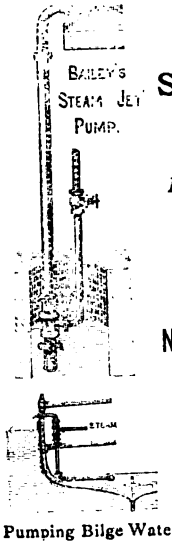

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THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

VOLUME XLVIII.—1883.

LONDON:
PUBLISHED AT THE OFFICE, BOY COURT, LUDGATE HILL, E.C.
AND SOLD BY ALL BOOKSELLERS.

MDCCCLXXXIII.

THE CHEMICAL NEWS.

VOLUME XLVIII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1232.—JULY 6, 1883.

ON LINE SPECTRA OF BORON AND SILICON.*

By W. N. HARTLEY, F.R.S.E., &c.,
Royal College of Science, Dublin.

In the course of an extended examination of all varieties of saline solutions by means of the spark and a photographic camera, I have observed two spectra of much interest. I detach my notes from the paper in which they are embodied in order to give them an earlier publication.

Boron.—In order to ascertain whether sodium borate would yield any spectrum beyond that due to sodium, a strong solution of borax was first examined and subsequently a saturated solution of boracic acid. The graphite electrodes with which the solution was submitted to the action of the spark, was opposed to a pole of a tin-cadmiun alloy, in order that the wave-lengths of any lines that might appear could be determined by reference to those of tin and cadmium. It is a remarkable fact that when a saturated solution of borax is used, the sodium lines are not visible, while there appear three strong sharp lines, which as they were likewise yielded by boracic acid, must be considered as characteristic of boron.

The Spectrum of Boron.

Scale numbers.	Wave-lengths.
96·18	3450·3
269·20	2497·0
269·48	2496·2

Silicon.—A strong solution of sodium silicate was in like manner submitted to the action of the spark. There was only a feeble indication of the strongest sodium line (λ=3301), but a strong spectrum was obtained consisting of a beautiful group of lines with three isolated rays. These lines are attributed to silicon, because they are rendered equally well by sodium silicate, sodium fluosilicate, and by hydrofluosilicic acid, the electrodes being either of gold or of carbon. The strength of the lines is proportional to the strength of the hydrofluosilicic acid solution examined. The fiducial lines of the tin-cadmiun alloy and some of the air lines were employed as before in obtaining measurements from which the wave-lengths of the silicon lines were calculated by means of an interpolation curve. Below are given the wave-lengths of the silicon lines, together with their scale numbers referring to their position and the prism spectrum. The scale numbers are comparable with those given in a paper recently submitted to the Royal Society, and are also applicable to my photographs of spectra in the *Journal of the Chemical Society*, vol. 41, p. 90. They represent hundredths of an inch and fractions thereof, reckoned from a strong air line with wave-length 4628·9, which is numbered 10. (Measurements of the Wave-lengths of Lines of High Refrangibility in the Spectra of Elementary Substances": Hartley and Adeney.)

The Spectrum of Silicon.

Scale numbers.	Wave-lengths.
178·98	2881·0
233·17	2631·4
256·78	2541·0
260·36	2528·1
261·65	2523·5
263·07	2518·5
263·98	2515·5
264·44	2513·7
266·54	2506·3
288·00	2435·5

These are the first spectra of boron and silicon obtained from metallic salts. In Messrs. Liveing and Dewar's map of the carbon spectrum (*Proc. Roy. Soc.*, vol. 33, p. 403), I have observed a group of lines not seen in the spectrum of graphite obtained by me (*Journal of the Chemical Society*, vol. 41, p. 90), which might be accounted for by a difference in strength of the spark employed. This group, however, resembles in a striking manner the seven lines in the spectrum of silicon. (See the map of the silicon spectrum.) Their wave lengths are the following—2541·0, 2528·2, 2523·6, 2518·7, 2515·8, 2514·0, 2506·3. It will be seen by comparison that these lines approximate so closely to those of silicon that the numbers are well within the experimental errors of measurement of identical lines. Professors Liveing and Dewar took the lines which they mapped from sparks passed "between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal gas. The same lines have been observed in photographs of the spark between iron, and between aluminium poles in carbonic acid gas." "The graphite was purified by being stirred in fine powder into fused potash, and subsequent treatment with *aqua regia*, by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid." "Notwithstanding the purification the photographs of the spark between these electrodes still showed very distinctly the lines of magnesium and iron."

* A Paper read before the Royal Society, June 21, 1883.

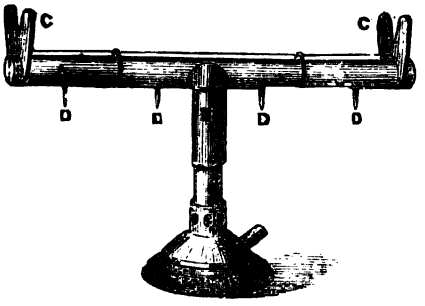
From these quotations it will be seen with what great care the preparations for these observations on the carbon spectrum were made. If the poles employed had been those of graphite only, I should have had little hesitation in attributing the six lines to the silicon spectrum, but they were replaced by iron and by aluminium. Even the purest iron wire contains small traces of silicon, and aluminium of the usual commercial quality certainly contains a considerable quantity. There is, therefore, a suspicion that the carbon spectrum was contaminated by silicon, for a series of seven consecutive lines so nearly coincident with those in the spectrum of another element of the same class would be very remarkable.

A LONG-FLAME BUNSEN BURNER.

By W. RAMSAY, Ph.D.

I HAVE long felt the want of a Bunsen's burner which should heat short lengths of combustion-tubing to redness for such purposes as incinerating weighed amounts of ash containing carbon, separating small amounts of elements which form volatile chlorides from elements the chlorides of which do not volatilise at a red heat, and for similar operations. Such a burner should be easy to manipulate, efficient, and inexpensive. I have devised the form represented in the annexed figure, which, I think, fulfils these requirements.

It consists of a brass tube, A, with a brass T-piece, which can be fitted on to an ordinary Bunsen's burner, at



right angles to the tube A. The horizontal tube is slit from end to end; it is closed at both ends, and provided with supports, C C, in which the glass tube rests. As a substitute for stopcocks are four pieces of wider brass tubing which encase A, also slit along top, provided with brass pegs, D D D D, by means of which each can be moved so that the slit in A no longer coincides with the slits in the encasing tube. When the two slits coincide there is free passage for gas; but when the external tubes are made to revolve on A the gas is shut off, and the flame is extinguished. Each encasing tube is 2 inches long, the whole tube being 8½ inches in length. At one end of A a circular piece of brass projects for 3-16ths of an inch, and on the lower side a short peg is inserted. On the other end there is a corresponding annular projection, designed to receive the circular projection of another burner; in the ring there is a slot into which the peg from the second burner fits. The object of this is to connect one burner with another so as to form a furnace of a series of three or four burners. Such a series answers the purpose of an ordinary combustion-furnace, and has the following advantages:—It is much less cumbrous; the gas can be more conveniently regulated than in an ordinary furnace, and combustion-tubes consequently last for a longer time; there is no disagreeable smell, so that a combustion-room is not required; the combustion can therefore be performed on an ordinary laboratory bench; and the length of the furnace can be modified by using as many or as few burners as desired. There is, moreover, no danger of the flame "burning below"; it is a clear blue flame.

For organic analysis it is advisable to have special Bunsen's burners, giving flames about 10 inches high, else the temperature is not sufficiently high; but the combustion-tube must then be protected with wire-gauze. To prevent upward radiation of heat it is convenient to lay on the top of the tube several long pieces of asbestos cardboard: these are easily removed by crucible-tongs during the combustion; hence its progress is easily watched.

By performing the combustion in an open tube, in a stream of oxygen, it is easy to complete four in a day of six hours with a double set of absorbing tubes and bulbs; and indeed a rapid worker may accomplish seven. This, of course, depends on the nature of the substance burned; but with bodies which have a large carbonaceous residue when heated, such as sugar, no attention is needed after the first evolution of gas has ceased, and while the combustion is proceeding the second set of tubes may be weighed.

I have only to add that the flame may be regulated by turning the external tubes quite as well, if not better than, with stopcocks.

University College, Bristol, June 24, 1883.

RUSSIAN BASIC STEEL.

By SERGIUS KERN, M.E., St. Petersburg.

IT was a very interesting object for the writer to test the qualities of the basic steel of Russian manufacture. Near St. Petersburg, the Alexandrovsky Steel Works are commercially working the basic process in Siemens-Martin furnaces.

The plate steel welds quite like iron; in fact the Nevsky Works, St. Petersburg, rolling the ingots, make, out of the remaining scrap, piles which heated to a welding heat are rolled into capital plates for different purposes.

The following are the results of trials of the steel plates:—

Unannealed Plate.

Thickness in Inches.	Breaking weight: Tons per Square Inch.	Elongation in 8 Inches. Per cent.
½	26	29

Annealed Plate.

½	22	36·25

The chemical composition of the steel runs as follows:—

	Per cent.
Carbon	0·10
Manganese	0·43
Phosphorus	0·02
Sulphur	0·02
Silicon	traces
Copper	none

I am informed that the raw materials charged into the furnace contain, on the average, 0·75 per cent of phosphorus.

I am very happy to state that the great invention of Messrs. Thomas and Gilchrist is worked in Russia in such a satisfactory way.

Panification.—V. Marcano.—The author has never been able to find in fermenting bread any trace of *saccharomyces*. The organism common in it is a movable sphero-bacterium. During the process of panification the gluten and a part of the albumenoids are partially dissolved and converted into peptones, not precipitable by tannin. There is also formed amylase, a secretion-product of the microbia.—*Comptes Rendus.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

THE atomic weights of these seven elements depend upon each other to so great an extent that they can hardly be considered independently. Indeed, chlorine, potassium, and silver have aways been mutually determined. From the ratio between silver and chlorine, the ratio between silver and potassium chloride, and the composition of potassium chlorate, these three atomic weights were first accurately fixed. Similar ratios more recently worked out by Stas and others, have rendered it desirable to include bromine, iodine, sulphur, and sodium in the same general discussion,

Several methods of determination will be left altogether out of account. For example, in 1842 Marignac* sought to fix the atomic weight of chlorine by estimating the quantity of water formed when hydrochloric acid gas is passed over heated oxide of copper. His results were wholly imaccurate, and need no further mention here. A little later Laurent† re-determined the same constant from the analysis of a chlorinated derivative of napthalene. This method did not admit of extreme accuracy, and it presupposed a knowledge of the atomic weight of carbon; hence it may be properly disregarded. Maumené's‡ analyses of the oxalate and acetate of silver gave good results for the atomic weight of that metal; but they also depend for their value upon our knowledge of carbon, and will, therefore, be discussed further on with reference to that element.

Let us now consider the ratios upon which we must rely for ascertaining the atomic weights of the seven elements in question. After we have properly arranged our data we may then discuss their meaning. First in order we may conveniently take up the percentage of potassium chloride obtainable from the chlorate.

The first reliable series of experiments to determine this percentage was made by Berzelius.|| All the earlier estimations were vitiated by the fact that when potassium chlorate is ignited under ordinary circumstances a little solid material is mechanically carried away with the oxygen gas. Minute portions of the substance may even be actually volatilised. These sources of loss were avoided by Berzelius, who devised means for collecting and weighing this trace of potassium chloride. All the successors of Berzelius in this work have benefitted by his example; although for the methods by which loss has been prevented we must refer to the original papers of the several investigators. In short, then, Berzelius ignited potassium chlorate, and determined the percentage of chloride which remained. Four experiments gave the following results:—

60·854
60·850
60·850
60·851

Mean .. 60·851 with a probable errror of ± 0·0006

The next series was made by Penny,¶ in England, who worked after s somewhat different method. He treated potassium chlorate with strong hydrochloric acid in a weighed flask, evaporated to dryness over a sand-bath, and then found the weight of the chloride thus obtained. His results were as follows in six trials:—

60·825
60·822
60·815
60·820
60·823
60·830

Mean .. 60·8225 ± 0·0014

In 1842 Pelouze* made three estimations by the ignition of the chlorate with these results:—

60·843
60·857
60·830

Mean .. 60·843 ± 0·0053

Marignac, in 1842,† worked with several different re-crystallisations of the commercial chlorate. He ignited the salt, with the usual precautions for collecting the material carried off mechanically, and also examined the gas which was evolved. He found that the oxygen from 50 grammes of chlorate contained chlorine euough to form 0·003 grm. of silver chloride. Here are the percentages found by Marignac:—

In chlorate once crystallised	60·845
In chlorate once crystallised	60·835
In chlorate twice crystallised.. ..	60·833
In chlorate twice crystallised.. ..	60·844
In chlorate three times crystallised..	60·839
In chlorate four times crystallised..	60·839

Mean .. 60·8392 ± 0·0013

In the same paper Marignac describes a similar series of experiments made upon potassium perchlorate, $KClO_4$. In three experiments it was found that the salt was not quite free from chlorate, and in three more it contained traces of iron. A single determination upon very pure material gave 46·187 per cent. of oxygen and 53·813 of residue.

In 1845 two series of experiments were published by Gerhardt.‡ The first, made in the usual way, gave these results:—

60·871
60·881
60·875

Mean .. 60·8757 ± 0·0020

In the second series the oxygen was passed through a weighed tube containing moist cotton, and another filled with pumice stone and sulphuric acid. Particles were thus collected which in the earlier series escaped. From these experiments we get:—

60·947
60·947
60·952

Mean .. 60·9487 ± 0·0011

These last results were afterwards sharply criticised by Marignac,§ and their value seriously questioned.

The next series, in order of time, is due to Maumené.|| This chemist supposed that particles of chlorate, mechanically carried away, might continue to exist as chlorate undecomposed; and hence that all previous series of experiments might give too high a value to the residual chloride. In his determinations, thefefore, the ignition tube, after expulsion of the oxygen, was uniformly heated in all its parts. Here are his percentages of residue:

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Comptes Rendus*, 14, 570. Also, *Jour. f. Prak. Chem.*; 26, 304.
‡ *Comptes Rendus*, 14, 456. *Jour. f. Prak. Chem.*, 26, 307.
§ *Ann. d. Chim. et d. Phys.*,(3), 18, 41. 1846.
|| *Pogg. Annalen*, 1826, bd. 8, s. 1.
¶ *Phil. Transactions*, 1839, p. 20.

* *Comptes Rendus*, 15, 959.
† *Ann. d. Chem. u. Pharm.*, bd. 44, s. 18.
‡ *Comptes Rendus*, 21, 1280.
§ *Supp. Bibl. Univ. de Genève*, vol. I.
|| *Ann. d. Chim. et d. Phys.*, (3), 18, 71. 1846.

60·788
60·790
60·793
60·791
60·785
60·795
60·795

Mean .. 60·791 ± 0·0009

The question which most naturally arises in connection with these results is, whether portions of chloride may not have been volatilised, and so lost.

Closely following Maumené's paper there is a short note by Faget,* giving certain mean results. According to this chemist, when potassium chlorate is ignited slowly, we get 60·847 per cent of residue. When the ignition is rapid we get 60·942. As no detailed experiments are given, these figures can have no part in our discussion.

Last of all we have two series determined by Stas.† In the first series we have the results obtained by igniting the chlorate. In the second series the chlorate was reduced by strong hydrochloric acid, after the method followed by Penny:—

First Series.

60·8380
60·8395
60·8440
60·8473
60·8450

Mean .. 60.84276 ± 0·0012

Second Series.

60·850
60 853
60·844

Mean .. 60·849 ± 0·0017

(To be continued.)

SOME NOTES ON THE CINCHONA ALKALOIDS: A TEST FOR THE PURITY OF QUININE.

By C. H. WOOD and E. L. BARRET.

I. *Hydrate of Quinine and Quinidine.*—In the CHEMICAL NEWS (vol. lxv., p. 6) we briefly describe a crystalline compound of quinine and quinidine that we had obtained from a solution of the two alkaloids in ether. Our results indicated that the quinine and quinidine were present in this crystalline body in equal proportions, but they had been roughly obtained, and were not sufficiently exact to warrant any very positive statement on this point. We have now prepared this compound in several ways and are able to furnish more accurate results.

1. Ten grammes of pure effloresced quinine sulphate, prepared from calisaya bark, were dissolved in acidulated water, and the solution shaken in a bottle with 170 c.c. of pure ether. An excess of sodic hydrate solution was then added and the whole shaken together. When the precipitated quinine had dissolved in the ether and the two layers had separated, a few c.c. of alcohol were poured into the ether to prevent gelatinisation, and the lower aqueous liquid was syphoned out. The clear ethereal solution was decanted into a large bottle. Ten grammes of pure quinidine sulphate were dissolved in acidulated water and the solution shaken in a bottle with 900 c.c. of pure ether, an excess of sodic hydrate solution added, and the whole shaken together. When the precipitate had dissolved in the ether and separation had occurred, the aqueous liquid was syphoned out, the ethereal solution decanted into a clean vessel, and then poured into the bottle containing the etherial solution of the quinine hydrate. A few minutes after mixing these etherial solutions groups of small crystals began to form on the sides of the bottle, and by next day an abundant crystalline precipitate had formed. This was collected on a filter, washed with fresh ether, pressed between bibulous paper, and dried by exposure to the air. It weighed 13 grms. The ethereal filtrate and washings were distilled down to about 250 c.c., and this concentrated mother-liquor, after some hours, deposited a further crop of crystals exactly resembling the first. The liquor decanted from these was distilled to dryness and left a residue, which gradually became perfectly crystalline. Analyses of the first crop of crystals obtained gave the following results:—

Quinine	47·06 ..	46·91 ..	47·29
Quinidine	45·96 ..	46·29 ..	46·36
Water	6·98 ..	6·80 ..	6·35
	100·00	100·00	100·00

These numbers agree sufficiently well with

$$C_{20}H_{24}N_2O_2.C_{20}H_{24}N_2O_2.2\tfrac{1}{2}H_2O,$$

which corresponds to—

Quinine	46·753
Quinidine	46·753
Water	6·494
	100·000

By exposure in a desiccator for five or six days the crystals lost the half molecule of water. The second crop of crystals obtained in the foregoing operation agreed with the first in composition.

2. Equal quantities of quinine and quinidine (alkaloid) were dissolved together in ten times their joint weight of weak spirit (sp. gr. 900=58 per cent by weight) by the aid of heat, and the solution left to crystallise. Prismatic crystals soon began to form. Next morning the liquid was decanted, the crystals drained, dried quickly by pressing between bibulous paper, and analysed. They gave—

Quinine	46·29
Quinidine	45·55
Water	8·16
	100·00

Three molecules of water to the two molecules of alkaloid (648+54) require only 7·69 per cent. Probably, therefore, the crystals retained a little external moisture when taken for analysis. A portion of the same crystals exposed in a desiccator over sulphuric acid for forty-eight hours lost 1·51 per cent, retaining 6·65 per cent of water. Consequently in this state they corresponded very closely with the crystals obtained from ether. The remainder of the crystals from spirit not used for analysis were again dissolved in ten parts of weak spirit of the same strength, and the solution left to crystallise. The resulting crystals dried as before gave on analysis numbers almost identical with those just stated for the first crystallisation.

3. Two grms. of quinidine sulphate were dissolved in acidulated water and the solution put in a bottle with 60 c.c. of pure benzene, warmed to about 40° C, and sodic hydrate solution added in excess. The mixture was well shaken, and when the precipitate had dissolved in the benzene and separation of the two liquids had occurred, the lower layer was syphoned out, and the benzene solution filtered. Two grms. of effloresced quinine sulphate were then treated in the same way, but using 90 c.c. of benzene instead of 60. To this filtered benzene solution, while still warm and before it crystallised, the benzene

* *Ann d. Chim. et d. Phys.*, (3), 18, 80. 1846.
† See Aronstein's "Translation," 249.

solution of quinidine prepared as above was added. As the mixture became cloudy it was warmed till clear, and then left. A crystalline precipitate soon began to form, and next day this was collected on a filter and pressed between bibulous paper till apparently dry, when it weighed 4·6 grms. Left in a loosely covered vessel, it weighed on the following day 3·42, and two days after 3·23 grms. In this state it was analysed, and gave the following results:—

Quinine	42·56
Quinidine	41·82
Water	4·91
Benzene	10·71
	100·00

The formula $C_{20}H_{24}N_2O_2.C_{20}H_{24}N_2O_2.2H_2O+C_6H_6$ requires—

Quinine	42·52
Quinidine	42·52
Water	4·72
Benzene	10·24
	100·00

As the apparently dry substance had been exposed for three days in such a manner that evaporation could occur before it was analysed, it seemed evident that at least one molecule of benzene was a constituent of the crystals, and it is even possible that when first removed from the liquid they contained more than one molecule.

From the foregoing results it was seen that the body which we have described as a compound of quinine and quinidine, when prepared as indicated from ether, from weak spirit, or from benzene, always contains water, and is therefore a hydrate of the two alkaloids. We noticed in analysing the body that the quinine and quinidine together, when rendered anhydrous, had a notably lower fusing-point than either alkaloid has alone. This fused and anhydrous body, when dissolved by a gentle heat in 12 parts of pure well-dried benzene and the flask securely corked, formed a solution which after standing ten days had only yielded a slight crystalline precipitate too small in quantity to be worth collecting. On removing the cork, however, and leaving the solution exposed to the air, a copious crystalline precipitate soon formed, and in a couple of days the liquid was half filled with it. This, collected on linen, pressed, dried on bibulous paper, and analysed, gave 4·30 per cent. of water and 16·55 of benzene. It would appear from this that the anhydrous alkaloids in benzene are capable of absorbing water from the air to form the hydrate.

II. *Quinine Hydrate Crystallised from Benzene.*—Thirty grammes of quinine sulphate were dissolved in acidulated water, 900 c.c. of pure benzene added to the solution, and the whole warmed in a bottle to about 40° C. Excess of sodic hydrate solution was then poured in and the mixture well shaken. The precipitate dissolved completely in the benzene, and when the two liquids had separated the lower layer was removed by a syphon, and the benzene solution quickly passed through a filter into a dry beaker. As this solution cooled it began to deposit rhombic crystals, and after standing for twelve hours had yielded a plentiful crop. The liquid was then decanted, the crystals drained and turned on to bibulous paper to dry. When all the adherent moisture had gone they weighed 25 grammes. They were put in a dish loosely covered with a glass plate, left for two or three days, and then preserved in a bottle. Analysed after some weeks they gave—

Quinine	83·99
Water	4·70
Benzene	11·31
	100·00

A fresh quantity prepared in the same way gave—

Quinine	82·07
Water	4·68
Benzene	13·25
	100·00

The crystals as they first form are small separate rhombs, closely resembling those which cinchonidine yields from an etherial solution; but in growing they have a tendency to become longer and more prismatic. The first analysis we have given approximates sufficiently well to the formula $2C_{20}H_{24}N_2O_2.2H_2O+C_6H_6$, which requires—

Quinine	85·04
Water	4·72
Benzene	10·24
	100·00

And it indicates, therefore, that quinine hydrate crystallised from benzene agrees in general composition with the quinine and quinidine hydrate crystallised from the same menstruum. In both cases two molecules of alkaloid appear to be associated with two molecules of water and one of benzene. As these crystals, however, slowly lose benzene by exposure, there is the same sort of difficulty in determining the amount of benzene associated in the crystal that occurs in estimating the water of crystallisation of an efflorescent salt. That the benzene is inherent to the constitution of the crystals seems to us certain, for we have a sample of these quinine hydrate crystals prepared at least nine months back and since preserved in a loosely corked bottle standing on an upper shelf of a warm laboratory, that are devoid of all odour of the hydrocarbon, but are unchanged in appearance, and when dissolved in a little dilute acid in a test-tube still liberate benzene, which rises to the surface of the aqueous liquid, forming a visible layer. This sample was not analysed because it was not prepared from specially purified benzene. To get some idea, however, of the rate at which the crystals lose their benzene, about 3½ grammes of the first batch of crystals, the analysis of which is given above, were rubbed to fine powder, which was spread over a glass dish and exposed in vacuo. In the first twenty-four hours the loss was 0·95 per cent, in the second 0·44 per cent, and in the third 0·34 per cent. The dish was then placed under a larger receiver and left there for thirty-seven days. At the end of that time (forty days in all) the powder was found to retain 4·65 per cent. of benzene. The crystals in their unbroken state do not undergo so much change as the powder, and may be kept in an ordinary bottle without any apparent alteration.

III. *Quinine Crystallised from Benzene.*—When the crystals of the quinine hydrate from benzene are re-dissolved by heat in pure well-dried benzene, the solution on cooling deposits crystals of the hydrate in the same form as before, but mixed with acicular masses quite distinct in appearance. These needle-like crystals seemed to be formed from anhydrous quinine, and the following experiment was therefore made:—About 7 grammes of anhydrous quinine were dissolved by heat in 140 c.c. of pure dry benzene. When the solution had cooled, a minute fragment of a crystal of the quinine hydrate was dropped it. Crystallisation soon commenced, but entirely in the acicular form. After twelve hours a good crop of needles was obtained. These drained and pressed between fresh pieces of bibulous paper till they were apparently dry and then analysed, gave—

Quinine	76·58
Water	0·25
Benzene	23·17
	100·00

A portion of the crystals exposed in a watch-glass under a large receiver lost in nineteen hours 5·04 per cent, in another twenty-three 2·16 per cent, and again in eight days 4·15 per cent, making a total loss in ten days of 11·35 per cent, or about half the total quantity of benzene originally present. The rate of loss was most rapid during the first nineteen hours, and from that period rapidly diminished; if, therefore, the first loss of 5·04 be deducted from the benzene found in the original crystals, there remains—

Quinine	76·58
Benzene	18·13

which would be almost exactly the proportions required for $C_{20}H_{24}N_2O_2+C_6H_6$.

IV. *Cinchonidine Crystallised from Benzene.*—One part of pure cinchonidine was dissolved in 60 parts of pure benzene at the boiling temperature, and the solution allowed to cool. An abundance of acicular crystals was obtained. Dried on bibulous paper as before and analysed, they gave—

Cinchonidine ..	79·95
Benzene	20·05
	100·00

These numbers agree closely with $C_{20}H_{24}N_2O+C_6H_6$, but the crystals lose their benzene very rapidly. After fifteen days' exposure under a large receiver they contained 8·58 per cent, and after a few weeks only 1·76 per cent. A solution of cinchonidine sulphate shaken with warm benzene and soda, furnished a solution that yielded the same kind of acicular crystals containing, as was to be expected, no water.

The benzene used in the foregoing experiments was specially purified by taking well crystallised benzene, washing it with strong solution of potash, and distilling it over potassic hydrate, then digesting it at its boiling-point with 5 per cent of its weight of pure sulphuric acid, repeating the latter treatment till the acid ceased to acquire any sensible colour, then washing again with alkali, and distilling from potassic hydrate. To this product sufficient pure bromine was added to give it a permanent colour, and the washing with alkali, &c., repeated. The resulting benzene, when well dried, had a constant boiling point from the beginning to the end of the distillation, and in this state was used. The analysis of the bodies crystallised from benzene was effected by weighing the substance in a small two-necked flask, which was then placed in an oil-bath, and the temperature gradually raised to 140° C., while a slow current of well-dried air was passed through the flask and through three successive weighed $CaCl_2$ tubes attached to the exit neck of the flask. The current was continued until the exit air was free from the odour of benzene. The weight of the residue in the flask gave the percentage of alkaloid; the increase in the weight of the $CaCl_2$ tubes gave the water, and the difference of these two from the total gave the benzene.

V. *Quinine Hydrate and Cinchonidine from Benzene.—A Test for the Purity of Quinine.*—The foregoing results show that when a solution of quinine is precipitated by an alkali and shaken with warm benzene, the quinine hydrate dissolves and crystallises out again from the benzene in rhomboidal crystals. A solution of cinchonidine treated in the same way yields acicular crystals devoid of water. If a solution of quinine containing cinchonidine—say 10 per cent—be submitted to the same process, the benzene yields first the characteristic crystals of quinine hydrate and afterwards feathery groups of delicate needles. By removing the clear benzene into another vessel as soon as the bulk of the quinine hydrate has deposited, these acicular crystals may be obtained separately. They do not consist of cinchonidine alone, however, but contain quinine and cinchonidine crystallised together, the quinine being, in fact, the preponderating constituent. As the difference between these crystals and those of the quinine hydrate is very distinct, particularly when the crystals are examined through a pocket lens, it seemed possible to found upon it a method for the detection of cinchonidine in quinine. The result of experiments in this direction appears to us to be attended with a fair amount of success. The following is the mode of operating we have adopted:—Seven decigrammes of the quinine sulphate to be tested are put into a large test-tube and dissolved in twenty drops of diluted hydrochloric acid and 7 c.c. of water; 7 c.c. of benzene are then added and the tube placed in warm water, so as to heat the benzene layer to about 60° or 70° C.; 3½ c.c. of diluted ammonia are then poured in and the tube well shaken for about twenty seconds. The two liquids are allowed to separate from each other, and the lower layer is removed by a glass syphon filled with water. The tube containing the benzene solution is left at rest for about half an hour, or until the quinine hydrate has crystallised out, when the benzene is poured off through a little dry filter into a small *dry* test-tube (4 in. × ½ in.), and again left to crystallise. A few rhombic crystals of the quinine hydrate may occasionally again form, but these are to be disregarded. If the quinine sulphate contained 5 per cent of cinchonidine, within half an hour several feathery groups of delicate needles will begin to appear in the liquid, and these will increase so that after an hour or so they are abundant throughout the tube. With 2 per cent. of cinchonidine the formation of these crystals takes a longer time, but is generally quite distinct after two or three hours; and with 1 per cent, a few small groups can usually be found by a pocket-lens after three or four hours, and in twelve hours are quite visible. Smaller proportions of cinchonidine than even this are revealed after some days as the benzene slowly evaporates. When the quinine has been rigidly pure we have never found a trace of acicular crystals in the liquid, even after many days when the benzene has almost all gone. It is to be noted that the crystals should be looked for *within the liquid*, as the residue left on the upper part of the tube by the evaporation may give an erroneous impression. We have shown in Paragraph III. that it is possible to obtain acicular crystals of pure quinine from benzene under certain conditions. It is important to remember, therefore, that in using this test the method of operating given above must be strictly followed. But if this be done, and some experience of the appearance of the two sorts of crystals through a pocket lens has been acquired, we have reason to believe that the results obtained are trustworthy, and constitute a fair indication of the purity or otherwise of the quinine tested. For the purposes of this test absolutely pure benzene is not essential. The best benzene of commerce that will crystallise readily when put in a freezing mixture is sufficient. For pharmaceutical purposes the following proportions will probably be more convenient:—Ten grains of the quinine are dissolved in 20 minims of dilute hydrochloric acid P.B. and 2 fl. drms. of water. Two fl. drms. of benzene are added and the tube put in warm water to raise the benzene layer to a temperature of about 140° F. One fl. drm. of liq. ammonia P.B. is then added, and the test conducted as given above.

Royal School of Mines.—The third award of the medal and prize of books, given in 1881 by Sir Henry Bessemer, F.R.S., for the best Metallurgical Student of the year, has been made to Mr. H. F. Collins, who has just received an appointment as Assistant Resident Chemist at the important works of Rio Tinto, in Spain. The report for the current year of the Professor of Metallurgy points to the growing prosperity of the School of Mines and to the efforts that are being made, by visits to the metallurgical districts, to assimilate its teachings to that given in similar institutions on the Continent.

A NEW VOLUMETRIC METHOD FOR ESTIMATING ARSENIC.*

By LEROY W. McCAY, M.A., D.Sc.

At Freiberg, in Saxony, the following arsenic estimation method†, first suggested by Reich and afterwards developed by Reichter, is in vogue:—0·5 grm. of the finely pulverised ore is digested in a porcelain crucible, covered with a watch-glass, with concentrated nitric acid, and under the influence of heat until the residue assumes a lighter colour, and the sulphur, which separates out, has become of a pure yellow hue. After decomposition the watch-glass is rinsed with a few drops of water and the uncovered crucible heated upon the sand-bath in order to get rid of the excess of acid. A complete evaporation must be avoided. Four grms. of sodic carbonate are now added, the mass completely dried upon the sand-bath, 4 grms. of potassic nitrate introduced into the crucible, and the same heated until its contents flow quietly. The melted mass is permitted to remain in this state for ten minutes. After the crucible is cool it is brought into a dish and the fused mass extracted with hot water. The alkaline liquid, which contains the arsenic as arseniate of sodium, is acidified with a small amount of nitric acid, placed for two hours upon a hot sand-bath, in order to get rid of the carbon dioxide, mixed thereupon with a sufficient amount of silver solution (10 c.c. of a solution containing 100 grms. to the litre), and then neutralised with a dilute solution of ammonium hydroxide. Reddish brown arseniate of silver is precipitated. The precipitate is filtered, washed, well dried, shaken from the filter upon glazed paper, and the folded filter brought into a scarifier, and ashed in the glowing muffle. After the scarifier is cold the precipitate is shaken into the same, charged with ten assay tons of lead, and the silver determined in the usual way. From the silver found the amount of arsenic present is readily calculated. 100 grms. Ag = 23·1 grms. As.

So much for Reich and Richter.

The process here described is not in "Fresenius's Anleitung zur Quantitativen Chemischen Analyse," and for this very reason I have always been accustomed to regard it as only capable of affording approximate results. Results, in other words, perfectly satisfactory as far as the technical world is concerned, but in no wise in strict accordance with thoroughly scientific demands. Being unable to discover anything in detail as respects the method, I determined to look into the matter myself, and, if possible, settle my mind in regard to its perfections or imperfections.

The first question which appeared most worthy of consideration was whether the arsenic is completely precipitated upon the addition of the silver solution and subsequent neutralisation with ammonium hydroxide. A concentrated solution of ammonium arseniate was added to a strong solution of argentic nitrate, until the silver proved to be in excess, then neutralised with ammonium hydroxide, filtered, and washed. The silver contained in the filtrate was precipitated with hydrochloric acid, filtered off, the filtrate heated to boiling, and a stream of sulphuretted hydrogen permitted to pass through the liquid during an entire night. A small but perfectly distinct precipitate of yellow sulphide of arsenic was found at the bottom of the beaker. Four similar trials were made and in each case definite amounts of sulphide were forthcoming. This goes to prove that although the solution may be perfectly neutral *as far as its action upon litmus-paper* is concerned, some arsenic as arseniate of silver is sure to remain in solution. Concerning this point I find nothing in Post's description of Reich and Richter's method. All they say is, to neutralise carefully with dilute ammonium hydroxide.*

To bring down all the arsenic, avoid a re-dissolving of a portion of the same, and, at the same time, keep clear of a precipitation of silver oxide, I hit upon the following method of procedure:—Argentic nitrate was added in excess to a solution of ammonium arseniate, the same heated to boiling, and briskly stirred with a glass rod, first in one direction and then in another, until the liquid began to clear. It was then removed from the flame, cooled down to about blood heat, brought under a clip burette, and a very dilute solution of ammonium hydroxide (10:1) allowed to run in drop by drop until a cloud no longer appeared. In adding the ammonium hydroxide, after every two or three drops the liquid was thoroughly stirred, the precipitate permitted to settle, and the process continued until the last drop no longer produced a cloud. The precipitate was then filtered off and the filtrate tested for arsenic. Not a trace was discoverable. Numerous experiments were made, but when the conditions were properly complied with, absolutely no arsenic could be found by using sulphuretted hydrogen and Bunsen's flame reaction. Silver oxide is precipitated by ammonium hydroxide from a neutral solution of a silver salt, and it is only upon the addition of an excess of the alkali that the precipitate can again be brought into solution. The question now arises, is there not danger of precipitating some silver along with the arsenic? If so, will this not serve to vitiate the method? To settle the matter, I took about 2¼ c.c. of a strong solution of silver nitrate, diluted with water to about 50 c.c., and after heating to boiling, added a drop of the dilute ammonium hydroxide solution—no precipitate; two drops, no precipitate; three drops, no precipitate; twelve drops, none. The solution was next tested with litmus paper, but showed absolutely no alkaline reaction. When the ammonia was allowed to run in until the resulting reaction was faintly alkaline, a distinct cloud, due to the formation of silver oxide, made its appearance. This cloud, by permitting the solution to stand for some time, became larger and larger, but soon reached a maximum. In opposition, therefore, to Pearce and Low, I declare that the solution immediately prior to precipitation dare not be alkaline!

Fresenius says that argentic arseniate is slightly soluble in ammonium nitrate. I do not deny this fact, for it seems well established, but I must say that the amount of arseniate which does go into solution is so extraordinarily small that by the regular methods of analysis I have been unable to detect it. True, I have not made use of a Marsh apparatus, but, in the present case, I hardly deemed such precaution necessary.

The above points, then, being settled we can proceed.

As said Reich and Richter determine the silver contained in the arseniate by cupellation, and, from the weight of the silver button, estimate the arsenic. This will do very well for large works like the Freiberger-Hütten, where mufflers are running day and night, but in establishments not provided with furnaces of this kind, or in laboratories provided with them but only capable of firing up at certain seasons, the impossibility of a general and constant applicability of the process is at once evident.

To avoid this obstacle and at the same time render the method as *quick* as possible, I determined to make use

* This paper was already prepared for the press when Pearce and Low's investigations came to hand (*Science*, vol. i., No. 15). My method differs from their's in that it is based upon the principle of *Test*. My paper will serve to clear up several points which the above-named gentleman failed to completely ventilate. Such, for instance, as the relation existing between the argentic arseniate and ammonium nitrate, the exact degree of accuracy of the method, and lastly and chiefly, the device for hitting upon the precise moment at which the precipitation of the arsenic is most complete. It may perhaps be well to announce the fact that I first became acquainted with Pearce and Low's work about six hour's ago. June 12th, 1883.

† Post: Chimische-Technische Analyse.

* Pearce and Low simply say:—Neutralise carefully with ammonia, taking care that the liquid, when ready for precipitation, shall show an *alkaline* rather than an acid reaction.

of the principle of rest*, *i.e.*, determine the excess of silver in the filtrate.

Concisely stated, the method of procedure is about as follows:—

To the neutral solution of arsenic acid, heated to boiling in a small beaker, add from a clip burette a small excess of a standard solution of silver nitrate. The liquid is then briskly stirred with a glass rod until the precipitate begins to settle and the fluid to clear, removed from the flame, and permitted to cool down to about blood heat. The beaker with its contents is then brought under a second clip burette containing a dilute solution of ammonium hydroxide, and the ammonia permitted to drop in gradually until a cloud ceases to form. The liquid is stirred well after the addition of every two or three drops of ammonium hydroxide, so as to obtain a clear menstruum in which the cloud formation is readily observed or not as the case may be. The point at which the cloud disappears can be hit upon with a great degree of exactness, especially since the precipitate of arseniate of silver, being warm and curdy, settles rapidly and completely. The reddish brown arseniate is then filtered off and washed well, the filtrate acidulated with nitric acid, ferric sulphate added, and the silver determined volumetrically with thiocyanate of ammonium, according to Vollhard's method. The amount of silver found subtracted from the amount added gives a figure, from which the arsenic is readily calculated:—

100 Ag = 23·15 As.

I use the following solutions:—

(1) Ammonium hydroxide:
100 c.c. $(NH_4)OH$ to 1000 c.c. water.

(2) Argentric Nitrate:
39·352 grms. Ag NO_3 = 25 grms. Ag to 1000 c.c. water.

(3) Ammonium thiocyanate:
7·05 grms. to 1000 c.c. water.
1 c.c. = 0·00774 Ag.

(4) Ammonium ferric sulphate:
500 c.c. water saturated in the cold with the salt.

(5) Nitric acid:
Ordinary acid free from nitrous fumes.

I dissolved 4 grms. of ammonium arseniate in ½ litre of water, and used for each determination 10 c.c.; theoretically 10 c.c. of this solution should contain 0·0380 grm. As. However, for the sake of accuracy, I made two analyses by precipitating the arsenic as the double arseniate of ammonium and magnesium, moistening the precipitate with nitric acid and glowing, gently at first but finally strongly.

The quantities taken and those found were:

	C.c. Taken.	Grms. $Mg_2As_2O_7$	Grms. As.
(1)	10	0·0661	0·0368
(2)	10	0·0661	0·0367

Average = 0·03675.

10 c.c. were brought into a small beaker holding about 150 c.c., diluted to 50 c.c., and heated to boiling. 10 c.c. of the standard silver solution were then run in from the clip burette, the beaker removed from the flame, and its contents stirred diligently until the liquid cleared. After cooling down to blood heat the ammonia was added drop by drop until the precipitation proved to be complete. The cessation of the cloud formation serves to regulate this point. The washing was accomplished by decantation, about 25 c.c. being used each time. The filtrate was acidulated with 5 c.c. of the nitric acid (5), and, after the addition of 5 c.c. of the ferric sulphate solution, titrated with ammonium thiocyanate. As soon as a faint red tinge proved permanent, the addition of the thiocyanate was discontinued, and the number of cubic centimetres used read off. The number of c.c. multiplied by 0·00774 gave the Ag in the filtrate, and this, subtracted from 0·25, the number of grms. of Ag which went to form the arseniate. This amount multiplied by 23·15 = the arsenic contained in the 10 c.c. of the ammonium arseniate. Eight determinations were made.

	C.c. taken.	C.c. Ag sol.	C.c. $CNS(NH_4)$ sol.	Grms. As present.	Grms. As found.
1.	10	10	12·1	0·03675	0·0362
2.	10	10	12·1	0·03675	0·0362
3.	10	10	12·0	0·03675	0·0364
4.	10	10	11·9	0·03675	0·0365
5.	10	10	12·1	0·03675	0·0362
6.	10	10	12·0	0·03675	0·0364
7.	10	10	11·9	0·03675	0·0365
8.	10	10	11·9	0·03675	0·0365

Average = 0·03635
0·03675 − 0·03635 = 0·0004 difference.

Having worked so admirably as regards a salt—and an ammonium salt at that—I determined to try the method in estimating the arsenic in mattes and minerals.

With this object in view, a nickel matte from Freiberg, in Saxony, was finely powdered, 0·25 grm. carefully weighed out, mixed with from four to five times its weight of a mixture of equal parts of sodic carbonate and potassic nitrate, and thoroughly fused in a large porcelain crucible and over a good Bunsen burner for thirty minutes. The crucible and contents were then allowed to cool and extracted with hot water. The oxides of bismuth, cobalt, nickel and iron, together with some silica and alumina, being filtered off and washed, the filtrate was slightly acidulated with nitric acid, heated so as to expel CO_2, and then evaporated to dryness, and heated until acid fumes no longer appeared. The residue was taken up with water, the alumina and silica filtered off, and the whole filtrate diluted to 400 c.c. This amount was divided into two equal portions, and the arsenic determined as above described. Tabulated we have:—

	Cc. taken.	Grms. ore.	C.c. Ag sol.	C.c. $CNS(NH_4)$ sol.	Grms. Ag to form Ag_3AsO_4	Grms. As.	P. ct. As.
1.	100	0·0625	10	14·1	0·1410	0·03264	52·22
2.	100	0·0625	10	14·0	0·1416	0·03270	52·32

Again, 1 grm. of the matte was fused as above, the dissolved mass diluted to a litre, and for each determination 200 c.c. used. Tabulated we have:—

	C.c. taken.	Grms. ore.	C.c. Ag sol.	C.c. $CNS(NH_4)$ sol.	Grms. Ag to form Ag_3AsO_4	Grms. As.	P. ct. As.
1.	200	0·2	20	6 3	0·4513	0·10447	52·23
2.	200	0·2	20	6·2	0·4520	0·10463	52·31
3.	200	0·2	20	6 2	0·4520	0·10463	52·31
4.	200	0·2	20	6·1	0·4528	0·10482	52·41

Average = 52·30.

Two determinations were next made by precipitating the arsenic with magnesia mixture, moistening the precipitate with nitric acid, and glowing.

	Taken.	Found.
1.	200 c.c. = 0·2 grm.	0·2160 $Mg_2As_2O_7$ = 0·10458 As = = 52·29 per cent.
2.	200 c.c. = 0·2 grm.	0·2160 $Mg_2As_2O_7$ = 0·10458 As = = 52·29 per cent.

The results obtained volumetrically agree very remarkably with those obtained in the old way.

To test the method still further, a piece of speiskobalt from Schneeberg, in Saxony, was taken, finely powdered, and treated precisely as already indicated. I used 1 grm.

* It is just here that my method differs from that of Pearce and Low. They dissolve the precipitate in HNO_3 and determine the silver, while I obtain the silver in the filtrate and subtract it from the original amount added.

in this case, and diluted the solution of the fused mass to 1000 c.c. Six determinations were made volumetrically, 100 c.c. being taken each time. The remaining 400 c.c. were halved, and in each half the arsenic estimated by weight. Tabulated we have :—

	C.c. taken.	Grms. ore.	C.c. Ag sol.	C.c. CNS(NH_4) sol.	Grms. Ag to form Ag_3AsO_4	Grms. As.	P. ct. As.
1.	100	0·2	10	6·0	0·2036	0·04713	47·13
2.	100	0·2	10	6·0	0·2036	0·04713	47·13
3.	100	0·2	10	6·1	0·2028	0·04695	46·95
4.	100	0·2	10	6·0	0·2036	0·04713	47·13
5.	100	0·2	10	6·0	0·2036	0·04713	47·13
6.	100	0·2	10	6·0	0·2036	0·04713	47·13

Average = 47·10.

Again :—

	C.c. taken.	Grms. ore.	Grms. $Mg_2As_2O_7$	Grms. As.	Per cent. As.
1.	200	0·2	0·1945	0·0942	47·10
2.	200	0·2	0·1945	0·0942	47·10

The agreement with the mean of the volumetric results is perfect.

Before closing I would like to observe that I am endeavouring to discover the exact condition under which sulphide of arsenic may be so treated as to give a solution which may be tested as above described. Sulphide of arsenic, when oxidised with fuming nitric acid and then neutralised with potash, gives with nitrate of silver a precipitate which is not curdy but thick and muddy, and is sure to run through the filter. Excess of potassic nitrate added to the solution serves to check this disagreeable phenomenon, but not completely. I am inclined to attribute the anomaly to the excess of sulphuric acid present, generated by the action of the fuming nitric acid on the sulphur of the arsenic. By getting rid of the sulphate by means of barium nitrate this chasm may, I hope, be bridged over, and the method turn out as accurate as regards sulphide of arsenic as it has proved itself to be as regards arsenides.

John C. Green School of Science,
Princeton College, Princeton, New Jersey.
June 12th, 1883.

RECOGNITION OF GENUINE BEECH-WOOD CREOSOTE.

By H. HAGER.

PURE beech-wood tar creosote is not soluble in double its volume of anhydrous glycerin, but forms therewith a milky-white or whitish mixture, which ought not to be coloured. Other creosotes dissolve in double their volume of glycerin. To detect phenol, 3 vols. of a 75 per cent creosote are mixed with 1 vol. of the suspected creosote and well shaken. On settling there are formed two strata, a turbid one below and a lighter layer. The latter consists of the creosote which has given up its proportion of phenol to the lower stratum, its volume becoming smaller according to its proportion of phenol. In order fully to remove the latter (at least up to 98 per cent) from the creosote, the upper layer is again shaken up with three times its volume of 75 per cent of glycerin as before. On shaking up with ammonia at 5 per cent, the phenol passes into the latter, whilst the beech-tar creosote remains undissolved. If the sample is mixed with an equal volume of soda-lye at sp. gr. 1·334, it should form a clear yellow permanent liquid, a slight degree of heat being liberated. One vol. of beech-tar creosote dissolves completely and clearly in 2 vols. of petroleum benzine, and the solution should be almost colourless or yellowish. Creosote containing even 5 per cent phenol or cresol gives a turbid mixture. The solution of the creosote in petroleum benzine is divided into three parts. The first is shaken up with an equal volume of liquid ammonia, the second with caustic soda-lye of sp. gr. 1·160. In neither should a dark colouration appear in the course of half an hour. The third portion is shaken up with an equal volume of baryta-water. No blue, violet, or red colour should appear in either stratum of the liquid. Such colours would indicate tar-constituents, which should not be present in creosote. If 1 vol. creosote is shaken up with 2 vols. of a 15 to 18 per cent. ammonia, a genuine pure sample takes, at most, a lemon-yellow colour in the course of half an hour, and the upper aqueous stratum is pale or yellowish. Equal volumes of creosote and collodion should form a mixture, which remains colourless for half an hour.—*Zeitschrift für Analyt. Chemie.*

NOTE RELATIVE TO BERYLLIUM.

By J. EMERSON REYNOLDS, M.D., F.R.S.

I REGRET to find that Professor Humpidge's "reply" to my recent "note" on beryllium is founded, in its only material part, on the assumption that a portion of a sentence which occurs in my paper is an unqualified statement, whereas, in fact, it is specially qualified in the preceding paragraph by these words, "there appears to be a considerable, *though irregular*, rise in the specific heat of the element (beryllium) as the proportion of impurity diminishes." This statement necessarily governs all that follow, and is in exact accordance with the facts. While it is obviously true that the specific heat value of beryllium was greater in the two purer specimens (Nilson's 94·4 per cent and Humpidge's 93·97 per cent) than in Nilson's first material (87·09 per cent), I specially point out that the rise in value noted is *irregular*, and in order to prove this irregularity, and at the same time to suggest caution in dealing with the "chameleon element," I used substantially the same data as those now given in Professor's Humpidge's "Reply." In other words, it is shown that the samples of *nearly equal* apparent purity agreed in giving higher specific heats than Nilson's 87·09 specimen, but that they differed considerably between themselves in the same particular.

The only material point in Professor Humpidge's "Reply" has, therefore, no real foundation, and to require more from me would logically amount to a request for an express statement that of two *different* values one is greater than the other!

I regret that the above correction of the "Reply" should be necessary, as a mere discussion about terms is unsatisfactory.

The Late Mr. Spottiswoode.—At the annual general meeting of the Society of Arts, held on Wednesday last, June 27th, the following resolution was passed :—"That this meeting of the Society of Arts desires to express the deep regret with which it has received the news of the death of Mr. William Spottiswoode, one of its Vice-Presidents, and its sense of the loss which the Society has sustained by his decease. In him, England loses one of her most remarkable men of science, science itself one of its greatest ornaments, and all who knew him a sincere and valued friend. Besides devoting his own time and thought to the advancement of knowledge, he was ever ready to lend to all engaged in like pursuits the assistance of his experience and his wise counsel. In thus placing on record their own appreciation of his services, the Society desires to express its feelings of sympathy with his widow and his family, and also with the Fellows of the Royal Society, of which he was the honoured and beloved President."

THE LATE MR. W. SPOTTISWOODE,
PRESIDENT OF THE ROYAL SOCIETY.

As these lines are passing through the press, the remains of the late President of the Royal Society are finding a fitting resting place in Westminster Abbey, followed by a body of mourners, representing the scientific and intellectual life of England. The sad loss that Science has suffered of one of its ablest supporters, and one who might in no small degree be held up as the ideal of a hard-working and conscientious searcher after truth for its own sake, will be keenly felt by the scientific men of this country, of whom he was such a brilliant representative.

Our old English system, which makes the *savant* a private gentleman instead of a State official, a salaried academician, or an emeritus professor, has many advantages; but it is unobjectionable only in the case of men whose time is entirely at their own disposal. In spite of his being harassed with the every-day cares connected with the management of the business of the Queen's printers, Mr. Spottiswoode has, since the day he left Oxford a graduate with many honours, found time to accomplish a mass of scientific work, which, from the depth and range of subjects treated, shows him to have been a man of the highest intellectual endowments, combined with an unbounded capacity for doing work. As an inquirer into nature, one of his most striking characteristics was thoroughness. No expenditure of time and labour seemed to him too great to bestow upon anything which he had undertaken.

Gifted with what was by no means a robust constitution, had Mr. Spottiswoode been more sparing of himself instead of devoting his whole mental and bodily energies to the performance of whatever business was before him, there is little doubt that Science would not have to mourn the irreparable loss it has just suffered.

Mr. Spottiswoode's warm sympathy with the work and aims of a numerous circle of scientific men in diverse fields rendered him a true friend and supporter, and his great powers as an administrator have been amply exhibited by the valuable services he has rendered to the British Association, the Mathematical Society, the Royal Institution, and at the Council Board of the Royal Society.

As President of the Royal Society, Mr. Spottiswoode united qualifications for this high position which are rarely met with in combination. He who in these days fills the chair of Newton must be not merely a *savant*, of whatever eminence, but also a man of the world and of society, capable of holding his own in the highest circles. He is the official representative of science in the eyes of Government. Hence he must be a diplomatist, combining with the utmost courtesy a firm determination not to compromise the interest, of which, for the time being, he is the embodiment. This is in England a position of peculiar difficulty from the ill-will and contempt with which science is often regarded by politicians of both parties.

In Mr. Spottiswoode none of the attributes required were wanting. One of the most prominent features in his character was his many-sidedness. Though mathematics and physics were his own especial province, yet his knowledge and his interest were confined to no one department. Various as are the papers read before the Royal Society, he always showed himself willing and able to follow them, and his brief but appreciative comment in proposing a vote of thanks to the author proved how fully he had seized upon the main points brought forward.

It is superfluous for us here to enumerate the various scientific subjects that have been enriched by Mr. Spottiswoode's active and fertile brain. As a mathematician he entered upon speculations which to the routine man of Science are a stumbling block, and to the world at large foolishness, but which to the patient inquirer are signally suggestive. What if the poly-dimensional space thus conceivable by the mathematician really exists, and if the tri-dimensional character which we recognise in solids has its ground merely in the limitations of our own being? We must beware of rashly concluding that the speculations of such men as Spottiswoode and Clifford are mere exercises of analytical subtlety which can never bear fruit. For the most part his investigations are addressed to the mathematical student, and are draped in symbols intelligible only to the professed mathematician. In late years, however, Mr. Spottiswoode turned his abilities to the study of experimental physics, and as the result has contributed several important papers to the *Philosophical Transactions* and the *Proceedings of the Royal Society* on the "Polarisation of Light and on Stratified Discharges through Rarefied Gases."

In some quarters it has been hinted that Mr. Spottiswoode was a mere amateur. We do not quite know the meaning of this word as applied to a man of science, but if it is intended to convey the impression that he was only superficially acquainted with the many subjects on which he thought and wrote, nothing could be wider of the mark. Whatever subject Mr. Spottiswoode turned his mind to he "took the heart out" of it. His researches, though occasioning no controversies and being utterly free from anything of a sensational character, are eminently fertile, and what the Germans call *bahn-brechend*, opening out tracks to new regions of discovery.

ELECTROLYSIS OF BISMUTH SOLUTIONS.

By N. WILEY THOMAS and EDGAR F. SMITH.

In estimating bismuth in the electrolytic way, solutions of the sulphate, alkaline solutions of the citrate, and the latter in presence of free citric acid were used.

I. A weighed quantity of bismuthous oxide was dissolved in about 1 c.c. conc. sulphuric acid and then diluted to 100 c.c. with distilled water. 10 c.c. of this solution contained 0·0358 grm. metallic bismuth. In two experiments with this solution 10 c.c. of the same were placed in a small platinum crucible surrounded by a stout copper wire leading from the zinc pole of a three (one quart) celled bichromatic battery. Into the solution dipped a platinum wire connected with the carbon pole. The current ran three hours, was then interrupted, and the liquid quickly removed from the vessel. The deposited metallic bismuth, compact and perfectly regular, was washed first with water, then with alcohol, after which it was dried and weighed.

Found, *a*, 0·0354 grm. Bi; *b*, 0·0358. Required, 0·0358 grm. Bi.

In two additional experiments, instead of placing the bismuth solution in a crucible it was put into a beaker glass, diluted up to 100 c.c. with water, and a platinum crucible connected with the zinc pole was suspended in the liquid. The platinum wire from the carbon pole extended down below the crucible. The solution being so much more dilute than in *a* and *b*, the current was allowed to run five hours before being interrupted. The crucible, upon the outside of which the metal had deposited in a homogeneous form, was then removed, the coating washed as before, dried, and weighed.

Found, *c*, 0·0310 grm. Bi; *d*, 0·0355. Required, 0·0358.

The liquid remaining from *c* gave a brownish colouration with hydrogen sulphide.

This method can be employed with satisfactory results by using moderately concentrated solutions and having

the wire from the carbon pole not too far removed from the vessel upon which the metal is to be deposited.

II. Bismuth hydrate was dissolved in conc. citric acid and the liquid then made alkaline with sodium hydrate. The quantity of metal in solution was determined and definite portions of the liquid then electrolysed.

Found, 1, 0·0356; 2, 0·0358; 3, 0·0358. Required, 0·0356.

The slight difference is probably due to the difficulty experienced in removing the alkali and to errors in weighing. Only two of the previously mentioned cells were used. The time allowed for the precipitation was three hours. The deposit in each case was compact and regular.

III. An alkaline citrate solution of bismuth was acidified with citric acid and definite portions of it subjected to the action of the current. Two cells were employed and the average time for precipitation was two and a half hours. Required Bi=0·0356 grm; found:

1.—0·0358	7.—0·0357
2.—0·0353	8.—0·0356
3.—0·0352	9.—0·0357
4.—0·0358	10.—0 0358
5.—0·0356	11.—0·0358
6.—0·0358	12.—0·0356

Heat does not hasten the precipitation. In some instances when the current was not very brisk a slight deposition of oxide upon the wire was observed, but this invariably disappeared before the action of the current was interrupted.—*American Chemical Journal.*

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, July 2, 1883.

Sir FREDERICK POLLOCK, Bart., M.A., Manager and Vice-President, in the Chair.

J. G. Crawford and Gustavus Steinthal were elected Members of the Royal Institution.

The decease of Mr. William Spottiswoode, P.R.S., Manager and Vice-President of the Royal Institution, on the 27th June last, was announced from the Chair, to the deep regret of all the Members present.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

CORRESPONDENCE.

BROMINE WATER AS A TEST FOR STRYCHNINE.

To the Editor of the Chemical News.

SIR,—Professor Bloxam has asked me to communicate to you the following additional information with regard to the use of bromine water as a test for strychnine.

Having experienced a slight difficulty in obtaining the violet colour by proceeding according to the directions given in his article (CHEMICAL NEWS, vol. xlvii., p. 215), I found it an advantage to render the solution considerably acid, by adding a few drops of concentrated hydrochloric acid, and to boil before adding the bromine water. In this way the colour is produced more quickly, and is of a very much deeper shade, approaching, in a solution containing 1 per cent of strychnine, to the colour of a strong solution of cobalt nitrate.

The test is rather more delicate if a few drops of strong sulphuric acid be substituted for the hydrochloric acid, whenever it is practicable.

I have determined the delicacy of the test when applied as directed above. I find that a faint but perfectly distinct rose-pink is obtained in a solution containing 1-2000th of a grain of strychnine.

The colour increases in intensity directly as the strength of the solution of strychnine, and is quite permanent. The following experiment points to a valuable method for the quantitative estimation of strychnine by colour:—

A 1 per cent solution of strychnine was coloured to its maximum intensity by bromine water, and then diluted until the solution contained 0·1 per cent of strychnine.

A 0·1 per cent solution of strychnine was coloured to its maximum intensity by bromine water. The colour produced was identical with that of the diluted 1 per cent solution.

I would suggest that a coloured solution of strychnine of known strength should be taken as a standard, and the determination made in a way analogous to that for the determination of ammonia by Nessler solution.—I am, &c.,

HERBERT JACKSON.

King's College, London, July 3, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 24, June 11, 1883.

Separation of Gallium.—Lecoq de Boisbaudran.—Inserted in full.

Facts and Results serving for the Demonstration of Novel Properties.—M. Rohart.—Ferric sulphate, as neutral as is chemically possible, can form perfectly definite and very stable compounds with animal matters and the extractive principles of plants. It precipitates them from their solutions and preserves them from being re-dissolved or from being decomposed by the action of air. [The author's results, though not novel to chemists who have carefully studied the sewage question, may prove instructive to those who still maintain that dissolved organic matter cannot be precipitated by metallic salts. —*Ed.* C.N.]

Researches on Phosphoric Glass.—M. Sidot.—This glass, which is not attacked by hydrofluoric acid (*Comptes Rendus*, June 25, 1877), is now produced on the large scale.

Variation of the Capillary Constant of Surface of Ether Water and Carbon Disulphide Water under the Action of an Electromotive Force.—M. Krouchkoll.—The author has remarked that insulating liquids, such as carbon disulphide, ether, oil of turpentine, not miscible with water, when in contact with the latter liquid, acquire a decided conductivity, easily recognised by means of a Lippmann's electrometer. Further experiments proved that the capillary constant of the surfaces of water-ether, &c., vary under the action of an electromotive force in the same manner as that of a surface of water-mercury.

Formation of Bibasic Sodium Glycolate.—M. de Forcrand.—A thermo-chemical study.

Hydrates of Baryta.—E. J. Maumené.—The author maintains that hydrates with a single molecule of water are exceptional. The hydrate obtained by crystallisation in water has been repeatedly examined. Filhol gives it as containing 8 mols. of water, whilst Lescœur makes it 9 mols. The author finds 8·5 mols. The hydrate melted at a red heat contains 1·214 mols., whilst an intermediate compound contains 2·83.

Artificial Reproduction of Barytine, Celestine, and Anhydrite.—A. Gorgeu.—The author obtains these compounds by means of the solvent action of melted metallic chlorides upon the alkaline earthy sulphates.

No. 25, June 18, 1883.

Phosphorus Sulphides.—M. Isambart.—The author, whilst admitting the priority of M. Lemoine as regards certain facts brought forward in his paper of May 21st, points out that the conclusions respectively arrived at are not identical. M. Lemoine does not recognise the difference between the liquid sub-sulphide formed by mixing sulphur and phosphorus at 100°, and the sub-sulphide which has been exposed to a temperature higher than 130°.

Certain Properties of Tin Sulphide, Selenide, and Telluride.—A. Ditte.—Pure tin mono-sulphide is a brilliant substance, of a bluish metallic lustre, like that of galena; it is soft and friable, and its dust soils the fingers. Its formation is effected without notable liberation of heat, and its vapour is dissociated under the influence of heat. Its sp. gr. at 0° is 5·0802. Tin selenide is formed with a notable disengagement of heat and light. In its physical properties it much resembles the sulphide. Even at high temperatures it suffers very slight decomposition. Its sp. gr. at 0° is 6·179. Tin telluride is formed with a disengagement of light. It is not decomposed by the action of heat. It is of a greyish white colour and metallic lustre. Its sp. gr. at 0° is 6·478.

Determination of Carbonic Acid in the Air at the Stations of Observation of the Passage of Venus.—A. Muntz and E. Aubin.—The quantities observed are sometimes sensibly lower than those registered in France and Germany, and the maxima do not rise above ours. The general mean is 2·78, which is a little lower than that found by M. Reiset in the north of France (2·962), and the author's determinations in the plain of Vincennes (2·84), and on the summit of the Pic du Midi (2·86). The mean for the night (2·82) is slightly above the general mean.

Volumetric Determination of Carbon Disulphide in the Sulpho-carbonates.—E. Falières.—This paper, with the accompanying tables, do not admit of useful abstraction.

Emetics of Mucic Acid.—D. Klein.—[The term "emetics" is here applied generally to compounds considered analogous to antimony-potassium tartrate.] Mucic acid, like tartaric acid, belongs to the class of acids of mixed functions: it is an acid alcohol, and therefore, like tartaric acid, it forms true emetics. The author has obtained potassium and sodium boro-mucates, which are amorphous masses, very soluble, and closely resembling the potassium boro-tartrate; also an ammonium antimony mucate, and the corresponding potassium and sodium compounds.

Journal de Pharmacie et de Chemie.
Tome vii., June, 1883.

Action of Sulphur on the Oxides.—MM. Filhol and Senderens.—A thermo-chemical study of the behaviour of sulphur with potassa and soda, both in the solid state and in solutions more or less dilute. If potassa or soda is ground in a mortar with excess of sulphur there is obtained in a few moments a mixture of polysulphide and of hyposulphite. The action of sulphur upon dissolved alkalies becomes less and less easy as the solution is more dilute.

Modification of the Hydrotimetric Method.—L. Garnier.—The author finds that the alcoholic solution of soap used in determining the hardness of water often deposits a portion of its soap, which does not readily redissolve. To save time he proposes to filter, to re-standardise with calcium chloride or barium nitrate, and to calculate the results accordingly.

Researches relative to the Action of Zinc-Ethyl upon the Amines and Phosphines.—M. H. Gal.

Cosmos Les Mondes.
Tome v., No. 7, June 16, 1883.

Nitro-hydrochloric acid is coming into use in Italy as an antiseptic and ferment destroyer. For rendering suspicious waters potable it is recommended in the proportion of one part in 200 (2000?)

A new colour (*vinoline*) has been invented for the sophistication of wine. If boiled with sodium hyposulphite, the characteristic odour of nitro-benzol is developed. It is detected in wines by treatment with lime or baryta-water. A genuine wine takes a green tint, whilst if vinoline is present the red colour is merely darkened.

Archives Neerlandaises des Sciences Exactes et Naturelles,
Tome xviii., Part 2.

This issue contains no chemical or physical matter.

Bulletin de la Société Chimique de Paris.
No. 9, May 5, 1883.

The only original paper in this issue is a minute description of the production of the so-called Sèvres blue upon porcelain, furnished by M. Ch. Lauth.

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1233.

METHODS OF ANALYSING SAMARSKITE

And the other Columbates containing Earthy Oxides, by the Agency of Fluorhydric Acid; and of Dissolving Columbite and Tantalite by the same Acid.—On the Separation of Thoria from the other Oxides.—Quantitative Estimation of Didymium Oxide in its Mixtures with other Earthy Oxides.

By J. LAWRENCE SMITH, Louisville, Ky.

The study of this class of minerals has always presented considerable interest to the analytical chemist, from the time of the discovery of columbite by Hatchett in 1801, and tantalite and yttrotantalite by Ekeberg about one year later. These minerals for more than twenty years were the only known columbites and tantalites; since then about fourteen other well-defined species have been discovered and described, although the chemical formulæ of most of them are yet in doubt.

The metallic acids in these minerals have many interesting characteristics, which have already attracted special attention since H. Rose's researches in 1846 defining the distinctive characteristics of columbic and tantalic acid, which, prior to that date, had been considered by most chemists as being one and the same acid. M. Hermann, and later, M. Marignac, took up M. Rose's investigations, and gave to them considerable extension. The former thinks that he has discovered two additional metallic acids of the same type in the minerals in which the first two are found. The metals of these acids he has called ilminium and neptunium.* The labours of M. Marignac, as set forth in his various publications,† have contributed very largely to our precise knowledge of certain very important compounds of these acids, and he has also given the only reliable method of a close quantitative separation of columbic and tantalic acid.

An interesting chemical characteristic of these minerals is that nearly all of them have, as a portion of their bases, some one or more of the rarer earths, as the oxides of yttrium, erbium, cerium, thorium, and some new earths not yet fully defined. One reason for the comparatively imperfect study of the compounds of tantalum and columbium is the rarity of the minerals containing them; but since the discovery of comparatively large quantities of columbite and samarskite in the United States this difficulty is removed. Another obstacle to their study arises from the method of decomposing them, this being attended with more or less inconvenience when large quantities are to be operated on. This last difficulty will, however, be removed to a considerable extent by the analytical facts to be detailed in this communication.

In my published investigations in connection with the columbic and tantalic acid minerals from new localities in the United States‡ (more especially the remarkable developments of samarskite in North Carolina), the object in view was to detail all that was connected with their mineralogy, to describe the new species I had discovered, and to give a clear idea of their constitution in comparison with the same minerals as found elsewhere. In the analyses in that paper I did not give the relative proportions of columbic and tantalic acids, assigning as my reason at the time for this omission that the method I had worked with (Rose's) proved too unsatisfactory to warrant the waste of time in seeking after results that I was satisfied would be inaccurate. In this view I was sustained by M. Marignac, who has devised a much better method, which I have since tried, and which gives very good approximate results, within 1½ to 3 per cent, according to the amount of tantalic acid present. In the same paper I stated that the earths in samarskite did not appear to contain cerium oxide as does the Ural variety of the same mineral, although in the analyses then given I preferred noting the earths of that group as cerium oxides* until I could arrive at more satisfactory conclusions by renewed researches; for it is known that a small quantity of cerium oxide mixed with other oxides of that group may escape detection when the entire amount of oxides treated is very small; so it was thought better to repeat the experiments on larger quantities before making any conclusive statement as to the presence or absence of cerium oxide. Thoria, also, if present in the North Carolina samarskite, was there in too minute a quantity to warrant me in pronouncing upon it by the usual method of separation. All doubt, however, on this head has been dispelled by an easy and certain method I have discovered of separating it from the other earths, and, although present in the proportion of less than 1 per cent in the mineral, it can be separated and identified as well as any other constituent of the mineral, and that by operating with not more than three or four grammes of the mineral.

Method of Decomposing and Analysing Samarskite.

I shall first detail the method pursued in the analyses of samarskite, as this being one of the most complex of the columbates, all that is said in regard to it will be applicable to other forms of this class of natural compounds. The method most commonly employed for decomposing this mineral is by means of potassium bisulphate in the proportion of one part of mineral to six of potassium salt. This, it will be seen, introduces a very large amount of solid matter into the process, and, besides, requires careful heating to redness for some time. A more recent and better method is that proposed by Prof. Wolcott Gibbs,† viz., by the acid potassium fluoride (FlKFlHO). This method was used by M. Marignac in his most admirable and exhaustive labours on tantalic and columbic acid compounds already referred to. Concentrated sulphuric acid when heated with some of the columbates will decompose them more or less, but cannot be used in their analysis. The method about to be described is a decided improvement on either of the above, for reasons that will be rendered very apparent.

Decomposition by Fluorhydric Acid.‡

The quantity of samarskite used in the analyses is usually five grammes, and having an abundance of the material, special portions are used for the verification of certain results. The precipitates of all the ingredients are so dense and granular that filters 7 to 10 c.m. in diameter are used except in the iron precipitate. The mineral is triturated to a fine powder, and 5 grammes, dried at 150°

* *Jour. f. Prak. Chem.*, xv., 105. Chemists are not ready to recognise these as new substances, but rather as mixtures of tantalic and columbic acids.

† *Annales de Chim. et de Phys.*, viii., 1866, 115-75.

‡ *American Journal of Science*, May, 1877, 360.

* By this group is meant all the oxides forming insoluble double salts with the potash and soda sulphates, amounting to about 4 per cent of the mineral. Thoria, if present, was to be sought for among the oxides.

† *American Journal of Science*, xxxvii., 355.

‡ Not many years ago this acid was made and used in comparatively small quantities, but owing to the extended use of it in the arts, it is now manufactured on a large scale. One of the largest manufacturers of this acid in America is Feuchwanger, 118, Dey Street, New York, who furnishes a *fuming acid*, remarkably pure for a commercial article, at 25 cents per pound, in lead jugs of 30 lbs. capacity. The saturating property of 10 grammes of this acid is equal to that of 23 grammes of nitric acid of 1·42, costing 12 to 14 cents by the carboy, making the fluorhydric acid actually cheaper than the nitric acid. I have found in many laboratories what purports to be fluo hydric acid that is little less than sour water. When I desire pure fluorhydric acid, I distil the commercial acid of Feuchwanger in a small platinum still and condense in a very little distilled water, the vessel being surrounded by ice. In this way there is no annoyance from fluorsilicic acid.

C.,* weighed and placed in a small platinum capsule; one of 50 c.c. capacity is sufficiently large. This is moistened with about 5 or 6 c.c. of water, and then from 8 to 10 c.c. of concentrated fluorhydric acid is added (one-half at a time with an interval of two or three minutes), and the mixture stirred with a platinum rod. In a few seconds a vigorous action takes place: the mass becomes heated, and in from five to ten minutes the decomposition is complete without the application of heat. If the powder be exceedingly fine the decomposition is almost as rapid as that of calc-spar when chlorhydric acid is poured upon it.

The action is known to be complete by the disappearance of every black particle in the mass. The capsule is now placed on the water-bath to ensure complete decomposition and to evaporate away the larger portion of the liquid.

After the reaction the contents of the capsule are, 1st, a clear colourless solution; and, 2nd, a heavy green precipitate. The *solution* contains all the metallic acids, oxides of iron and manganese. The *insoluble portion* contains all the earths and uranium oxide. It is true that traces of iron will be subsequently found in the analysis of the insoluble part and traces of earth in the solution, but they are easily separated in the course of the analysis and properly placed in the estimates. They, however, only represent a fraction of 1 per cent.

It will be seen that thus far in a very few minutes the samarskite has not only been decomposed but partly analysed, for this perfect separation into two parts facilitates to a vast extent the subsequent operations.

To the contents of the capsule, decomposed as above stated, 30 c.c. of water are added; the whole is then warmed and thrown on a filter (8 c.m.) in a gutta-percha or silver funnel, the filtrate being received in a platinum capsule. The filtration takes place very rapidly, and the precipitate is well washed with hot water, a few drops of fluorhydric acid being added towards the end of the washing, to prevent a trace of the precipitate passing through the filter, which might otherwise occur. The filtering and washing is accomplished in fifteen or twenty minutes. As already stated, we have two classes of substances completely separated from each other, one soluble, the other insoluble. The soluble we call A, the insoluble we call B.

We will first consider A. This solution is evaporated over a water-bath, and before it reaches dryness concentrated sulphuric acid is added in excess to decompose the fluorides, about 1 c.c. acid to every gramme of metallic acid supposed to be present. The evaporation is completed by careful heating over the flame until the decomposition is complete and nearly all the sulphuric acid has been driven off. After cooling, water is added acidulated with chlorhydric acid, and the contents of the capsule washed out into a glass flask capable of holding one litre. When 5 grammes of the mineral have been used the liquid mass should be half a litre. A little chlorhydric acid is added. This is now boiled for one or two hours,† which can be done in an ordinary bottle.

After boiling, the contents of the vessel are thrown on a filter and thoroughly washed with hot water. The insoluble part remaining in the filter is columbic and tantalic acids with a little tungstic and stannic acid. This is dried, ignited, and weighed with all the usual precautions, and afterwards the tungstic and stannic acids are separated in the manner described by Rose, and the columbic and tantalic acids by Marignac's method.‡

The filtrate from the metallic acids is concentrated, and as it contains only iron and manganese, with mere traces of other oxides, they are separated and estimated in the usual way by the sodium acetate method. This disposes of part A. We now pass to the portion B, which is the insoluble part remaining after the first treatment with fluorhydric acid, and is composed of the fluorides of the earths and uranium. It is washed from the filter into a small platinum capsule. To this sufficient concentrated sulphuric acid is added to decompose the fluorides (about 2½ grammes suffice where 5 grammes of minerals are used), and the whole is concentrated as far as possible over a water-bath, and carefully heated over the flame until the excess of sulphuric acid is driven off, or very nearly so. After cooling, about 50 c.c. of water are added, and the capsule is gently heated on a water-bath, when the mass dissolves completely, furnishing a bright green solution. A minute amount of insoluble matter may sometimes show itself; this belongs to the metallic acid, and is separated and added to that obtained from A. It is usually only a few milligrms. The green solution is heated over the flame, and a little nitric acid is added, when the colour is changed to a lemon-yellow, from the higher oxidation of the uranium oxide. The solution is now introduced into a beaker, and increased to about 250 c.c. by the addition of water, and made to boil. It is then very nearly neutralised by ammonia, and oxalic acid or ammonium oxalate added very gradually. The precipitate, as is well known, will be first taken up and afterward become permanent. It consists of all the earths present. This is allowed to stand some six or eight hours, then thrown on a filter, and well washed. This oxalate of the earths I will call C, and proceed to treat of it a little further on, The filtrate contains all the uranium in solution with a trace of iron. This is concentrated to about 80 or 100 c.c., and then a concentrated solution of ammonium carbonate is added, which first precipitates the uranium oxide and then re-dissolves it. The solution is nearly clear with the exception of a few flocci of ferric oxide. This is warmed gently, and a few drops of ammonium sulphide are added, which precipitates every trace of iron. That is washed and estimated in the usual way, and represents from two- to three-tenths of one per cent of the mineral, and is added to the ferric oxide obtained from solution A. The filtrate containing the uranium oxide is evaporated to dryness, the ammonium salts driven off, and the oxide estimated by the ordinary method. In all the analyses thus far no solid matter is introduced by the reagents.

Before quitting this part of the subject I would state that there is no columbate that does not readily yield to this treatment by fluorhydric acid, as euximite, hatchettolite, fergusonite, &c., and so completely separate these minerals into two classes of substances (the metallic acids in a state of solution and the earths as insoluble compounds), that the weighing of the acid decomposed by the action of sulphuric acid as described will give at once an idea of the quantitative composition of the minerals.

Columbite and Tantalite.

It is well to make some remarks in reference to the columbite and tantalite and their decomposition by fluorhydric acid, for they are more difficult to decompose by any method than are the columbites of the earths.

Before we had the more powerful and convenient methods of decomposing minerals, Berzelius, Rose, and others had to resort to the finest possible sub-division of the mineral, often using a flat slab of agate and triturating with water. This fine trituration is sometimes, even now, employed in our present modes of manipulation. As the method I have adopted for years is more convenient than any I know of in use, it will not be out of place to refer to it here, for the whole operation is conducted in the same mortar in which the crushed mineral is first powdered.

If we have columbite to decompose, exceedingly fine dry trituration in an agate mortar suffices. To triturate properly, one gramme of columbite will require from ten to fifteen minutes in a 4-inch mortar. Thus pulverised, place the mineral in a platinum crucible or capsule, and

* Avoid heating to redness, for by so doing the mineral is not so readily acted on by the fluorhydric acid. I determine the loss by heat on a separate portion of 1 gramme.

† In my laboratory the boiling of liquids containing a heavy precipitate is always accomplished by driving steam through from a glass flask or small boiler, with two tubes, one bent at two right angles to drop in the liquid, and the other a straight one for a safety tube, thus preventing all thumping.

‡ *Annales de Chim. et de Physique*, viii., 1866, 115-175.

add about 5 grammes of fluorhydric acid of the strength alluded to in the first part of the paper; then heat over the flame on a plate of iron, so as to bring the temperature up to from 60° to 90° C. Half-an-hour suffices for complete solution; if any black powder remains, it is well to add a little more acid and heat again. A few flocci will sometimes appear in the solution, which is stannic oxide. In the analysis of tantalite the solution is not so easily accomplished, but I overcome that completely by my modification of the trituration of the mineral. After rubbing it up in the mortar for about five or six minutes, I add a little strong commercial (95 per cent) or absolute alcohol to the contents of the mortar, enough to cover completely the powder, then continue the trituration. The alcohol will soon evaporate; add a fresh portion; this I may have to repeat several times. The alcohol, like any other liquid, enables the pestle to reach thoroughly the coarser particles that always settle to the bottom. To triturate thoroughly, 1 gramme of the tantalite requires about twenty minutes. The contents of the mortar are like imperfectly-dried mud, and are kept at a temperature of about 150° C. in an air-bath for ten or fifteen minutes. A gramme of the material is then placed in a capsule or crucible of platinum, thoroughly dried, and carefully weighed. About 5 grammes of the fluorhydric acid are now added, and the heating conducted as in the case of columbite. Half-an-hour suffices to complete the solution, which is a clear liquid with a few white flocci in it that I have proved to be stannic oxide. While this method of solution appears to be a little tedious, I can assure those who try it that the manipulations are very simple, and there is no soluble matter introduced, as is the case when six or eight times its weight of potassium bisulphate is used. We now evaporate the solution of either columbite or tantalite to dryness; proceed as in the case of the samarskite. As there are no earths, however, in these minerals, there is little else than iron and manganese to deal with as associated with the metallic acids, which are decomposed by sulphuric for separation from iron and manganese as already indicated.

In regard to the separation of the two acids when they are in the same mineral, I use the method already referred to and first used by Marignac.*

The tungstic acid, stannic acid, &c., I estimate in the manner pointed out by Rose in his "Analytical Chemistry."

(To be continued.)

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Ruthenium.—Good results are obtained by means of the three following processes, the first of which is the most advantageous. The ruthenium should be in the state of sesquichloride.

1. The solution, strongly acidified by hydrochloric acid, is saturated with sulphuretted hydrogen, and then heated to a boil, which is kept up for fifteen to twenty minutes. A current of hydrogen sulphide is passed through the liquid all the time of the heating, and until it is cold. The ruthenium sulphide, collected upon a filter, is washed with sulphuretted hydrogen water, acidulated with hydrochloric acid. The evaporation of the filtrate gives gallium chloride.

2. The mixture is precipitated in heat with a small excess of caustic potassa, and the alkaline liquid is kept for some time in ebullition. The ruthenium oxide filtered off retains a little gallium. It is therefore re-dissolved in hydrochloric acid, and re-precipitated with potassa. Three or four treatments of this kind ordinarily suffice to eliminate the gallium, which is finally entirely contained in an alkaline solution, whence it is easily extracted by means of cupric hydrate.

3. Potassium ferrocyanide precipitates gallium very well in presence of ruthenium sesquichloride. The solution should be cold, and should contain one-fourth to one-third of its volume of hydrochloric acid. The gallium ferrocyanide is carefully washed with water strongly acidified with hydrochloric acid. If the ruthenium and gallium occur in a compound insoluble in hydrochloric acid, or in aqua regia, the substance is put in a gold crucible and attacked with a mixture of potassa and nitre at a dull red-heat. The aqueous solution of the resulting mass is treated with an excess of hydrochloric acid, and heated to boiling. The ruthenium exists as sesquichloride in the liquid thus obtained, and is separated by one of the processes above described.

Separation from Osmium.—The method given is exact, and is applicable to solutions containing either osmic acid or osmium chloride. The liquid is strongly acidified with hydrochloric acid, and is treated in the cold with a current of hydrogen sulphide; the temperature is then slowly raised to near ebullition, at which it is kept for about an hour, still continuing to pass the sulphuretted hydrogen. The filtrate, being saturated in the cold with hydrogen sulphide, and then raised to a boil, should not take a brown colour, which would show an incomplete precipitation of the osmium. There still remain, however, some slight traces of osmium in the colourless liquid. It is therefore well to pass sulphuretted hydrogen slowly through the liquid during its concentration. When the acid solution is reduced to a very small bulk there is added a little sulphuretted hydrogen water, and the mixture is boiled for a few minutes. A very small quantity of osmium sulphide is separated, and must be added to the bulk of the same compound previously obtained.

Separation from Arsenic.—In a strong hydrochloric solution hydrogen sulphide precipitates the arsenic entirely, whilst all the gallium remains in solution. The arsenic sulphide is washed with water acidified with hydrochloric acid, and not with pure water, to prevent the precipitate from passing through the filter.

Separation from Selenium.—According to circumstances one of the two following processes may be employed. The selenium should be present in the state of selenious acid.

a. The solution, rendered distinctly acid with hydrochloric acid, is treated with a current of hydrogen sulphide, whilst the temperature of the solution is gradually raised to a boil. The selenium sulphide is collected on a filter, and the filtrate yields gallium chloride on evaporation.

b. The liquid is acidified by hydrochloric acid, and the selenium is reduced by means of a current of sulphurous acid passed through the hot solution. The liquid is kept at a boil for ten to fifteen minutes, which agglomerates the selenium and prevents it from passing through the pores of the filter. The gallium is found in the filtrate. —*Comptes Rendus.*

ON SCOVILLITE, A NEW PHOSPHATE OF DIDYMIUM, YTTRIUM, AND OTHER RARE EARTHS, FROM SALISBURY, CONN.

By GEORGE J. BRUSH and SAMUEL L. PENFIELD.

In October last Mr. Joseph S. Adam, formerly an assistant in the Sheffield Laboratory, but now chemist of the iron furnaces at Lime Rock, Conn., sent one of us a mineral he had discovered occurring sparingly as an incrustation on some of the iron and manganese ores from the Scoville ore bed in Salisbury, Conn. Mr. Adam found the mineral to be a hydrous phosphate, and sent it to us for further identification.

* *Ann de Chim. et d. Phys.*, viii., 60. 1866.

The specimens which Mr. Adam kindly furnished us for examination show the mineral incrusting limonite and pyrolusite, very much as gibbsite coats the limonite of the Richmond ore bed. The incrustation is one-sixteenth of an inch or less in thickness, and is frequently botryoidal or stalactitic in form. On the cross fracture it presents a radiated fibrous structure. The colour is of a pinkish, brownish, to yellowish white. It has a silky to vitreous lustre on the fracture, but the natural surfaces have a greasy look, and in lustre and colour, as well as in form of occurrence, the mineral resembles some varieties of chalcedony or smithsonite. Hardness = 3·5. Sp. gr. 3·94 to 4·01.

The preliminary examination proved the mineral to be an infusible hydrous phosphate, affording no colouration when treated with cobalt solution, but when fused with salt of phosphorus and borax it gave a remarkable rose-coloured bead, both in the oxidising and reducing flames. The mineral is soluble in hydrochloric and nitric acids. Qualitative analysis showed it to be essentially a hydrous phosphate of the cerium and yttrium metals, with a trace of iron and a small amount of carbonic acid. As so few minerals contain these rare earths, and the methods for their separation and determination are frequently attended with difficulty and uncertainty, we have thought proper to give in detail the methods employed in the analyses.

The mineral was dissolved in hydrochloric acid, and the metals were precipitated from the acid solution as oxalates. The oxides obtained from igniting this precipitate were easily soluble in dilute acids, giving light rose-coloured solutions, from which, on addition of a solution of potassium sulphate, a precipitate of the sulphates of the cerium metals was separated. This precipitate, first freed from all traces of the yttrium metals, gave no reaction for cerium when tested by Gibbs's method* with peroxide of lead, but solutions of the oxides examined with the spectroscope showed the absorption bands characteristic of didymium. An acetic solution of the oxides was supersaturated with ammonia, and the precipitate which was formed was filtered off and thoroughly washed: this precipitate, when sprinkled with iodine, gave the characteristic blue colouration due to the presence of lanthanum.†

In the filtrate from the precipitated sulphates of the cerium metals, the yttrium metals were thrown down as oxalates from hot acid solutions. The precipitate had a faint pink colour, and when ignited and dissolved in acid the solution showed with the spectroscope the erbium absorption bands. The spark spectrum showed that yttrium was also present.

In the quantitative analyses, owing to the scarcity of pure material, the separate determinations were made on small quantities so as to give chances for repetition or variations in the method if necessary. The analyses were made on the air-dried mineral. It was found that the powdered mineral lost water, but it soon assumed a constant weight when dried at 100° C. The mineral dried at 100°, and then ignited in a Bohemian glass tube, gave the more firmly combined water which was collected in a chloride of calcium tube and weighed. Carbonic acid was determined by dissolving the mineral in a flask with dilute hydrochloric acid, and collecting and weighing the liberated gas in potash bulbs. In analysis II. the mineral, after drying at 100°, was directly ignited over the blast lamp, giving a loss of water and carbonic acid agreeing closely with the sum of the separate determinations in analyses I. and III. One direct determination of phosphoric acid was made with ammonium molybdate (analysis IV.). After filtering off the phosphorus precipitate the bases were precipitated from the filtrate by means of ammonia, and after the separation of traces of molybdenum and the cerium metals a volumetric determination of iron was obtained.

For the separation of phosphoric acid from the bases the following method was adopted:—The mineral being easily soluble in hydrochloric acid, a solution containing little free acid was obtained; this was poured into about 500 c.c. of boiling water containing enough ammonium oxalate in solution to unite with the bases to form oxalates; the separation of a crystalline precipitate of the oxalates soon took place, which was quite free from phosphoric acid, and contained all but traces of the bases: the solution and precipitate were allowed to stand over night, then filtered and washed with hot water. The filtrate was evaporated to small bulk, and the remaining oxide precipitated along with some phosphoric acid from the hot solution by means of ammonia. This small precipitate was collected and weighed, and the oxides separated from the phosphoric acid by means of mercurous nitrate.* From the filtrates the phosphoric acid was precipitated with magnesia mixture. The precipitates of the oxalates were brought together, strongly ignited over the blast lamp, and weighed. After weighing they were dissolved in sulphuric acid, and to the solution enough hot concentrated potassium sulphate solution was added to give when cold a saturated solution, and thus cause the precipitation of the lanthanum and didymium. These metals were not separated, but an attempt was made to determine the quantity of the didymium by igniting the nitrates obtained from a weighed quantity of the oxides in a current of oxygen, which should give, according to B. Brauner,† the higher oxide of didymium, Di_2O_5 and La_2O_3, and from the gain in weight of the oxide it was hoped that the quantity of didymium could be calculated. The results, however, were unsatisfactory, the gain in four trials being 7·5, 8·6, 6·9, and 8·2 per cent of the oxide employed. Pure didymium oxide with atomic weight 146·58 would require an increase of 9·38 per cent. A determination of the combined atomic weight of these oxides, made by converting a known weight of oxide into anhydrous sulphate, gave 142·6, which was the number used in calculating the results of the analyses.

The filtrate from the precipitated sulphates of the cerium metals was treated with ammonium oxalate to separate the yttrium metals. The precipitate of the latter being impure, it was in all cases re-dissolved and re-precipitated, and after ignition weighed as oxides. No attempt was made to separate the yttrium from the erbium. A determination of the combined atomic weight of the two oxides, made by converting a known weight of oxide into anhydrous sulphide, gave 115, indicating that the proportion of yttrium is about twice that of the erbium. Analyses I., II., III., and IV. were made on about 5 grammes; analysis V. on about a gramme. The results are as follows:—

	I.	II.	III.	IV.	V.	Mean.	Ratio.	
P_2O_5—								
	—	24·96	25·03	25·00	24·77	24·94	0·1756	
(Y_2O_3, Er_2O_3)—								
	—	8·34	8·67	—	8·51	8·51	0·0306	0·1977
(La_2O_3, Di_2O_3)—								
	—	55·30	54·87	—	55·34	55·17	0·1656	
Fe_2O_3—								
	—	—	—	0·24	0·26	0·25	0·0015	
Combined H_2O—								
	5·88	—	—	—	—	5·88	0·3267	
$CO_2 + H_2O$—								
	—	9·36	—	—	—	—	—	
H_2O lost at 100°—								
	—	1·50	1·49	—	—	1·49	0·0828	
CO_2—								
	—	—	3·59	—	—	3·59	0·0814	
						99·83		

In discussing these analyses the question at once arises as to whether the carbonic acid found is an essential con-

* W. Gibbs, *American Journal of Science*, II., xxxvii., 352.
† "Fresenius's Qualitative Analysis" (Johnson's edition), p. 125.

* Rose, "Quantitative Analyse," p. 524.
† *Ber. der Deutsch. Chem. Gesellsch.*, xv., 113.

stituent of the mineral. The carbonate does not appear to bear any simple relation to the phosphate, and we have thought best to regard it as due to an admixture of lanthanite $(La,Di)_2(CO_3)_39H_2O$. Regarding the water given off at 100° C. as representing only three molecules in the above formula, the remaining six going off at a higher temperature, we have the following ratio calculated with CO_2 as a basis :—

$$R_2O_3 : 3CO_2 : 9H_2O = 0{\cdot}0271 : 0{\cdot}0814 : 0{\cdot}2456 = 1 : 3 : 9{\cdot}06,$$

and there remains, after deducting the above, the ratio—

$$R_2O_3 : P_2O_5 : H_2O = 0{\cdot}1756 : 0{\cdot}1706 : 0{\cdot}1639 = 1 : 0{\cdot}97 : 0{\cdot}93,$$

or the ratio of a normal phosphate, plus one molecule of water $= R_2(PO_4)_2H_2O$.

If the water given off at 100° alone belongs to the carbonate, we have the following ratio for the carbonate:—

$$R_2O_3 : CO_2 : H_2O = 0{\cdot}0271 : 0{\cdot}0814 : 0{\cdot}0828 = 1 : 3 : 3{\cdot}06 = R_2(CO_3)_33H_2O,$$

and for the phosphate—

$$R_2O_3 : P_2O_5 : H_2O = 0{\cdot}1756 : 0{\cdot}1706 : 0{\cdot}3267 = 1 : 0{\cdot}97 : 1{\cdot}86 = R_2(PO_4)_22H_2O \text{ nearly.}$$

The former seems the more natural supposition, and accounts for a carbonate which is known to exist. The mineral as analysed may then be considered a mixture of lanthanite with the new phosphate in the following proportion :—

Lanthanite $R_2(CO_3)_39H_2O$.		Scovillite $R_2(PO_4)_2H_2O$.	
CO_2	3·59	P_2O_5	24·84
$(La,Di)_2O_3$ ..	9·03	$(Y,Er)_2O_3$ ..	8·51
H_2O	4·42	$(La,Di)_2O_3$.	46·14
	17·04 %	Fe_2O_3.. ..	0·25
		H_2O	2·95
		Scovillite ..	82·79
		Lanthanite .	17·04
			99·83 %

Below we have given the 82·79 per cent of scovillite calculated up to 100 per cent, and beside it that of a normal phosphate of the formula $R_2(PO_4)_2H_2O$, calculated from the atomic weights obtained from the analyses and with $(Y,Er)_2O_3 : (La,Di)_2O_3 = 1 : 4$.

	Scovillite found.	Calculated.
P_2O_5	30·12	29·46
$(Y,Er)_2O_3$	10·28	11·51
$(La,Di)_2O_3$	55·73	55·29
Fe_2O_3	0·30	—
H_2O	3·57	3·74
	100·00	100·00

The only mineral which approaches this composition is churchite,* a phosphate of cerium, didymium, and lime, with four molecules of water. Our mineral contains less water, is free from cerium and lime, and differs also entirely from churchite in physical characters. It is therefore a new mineral species, and we propose for it the name *Scovillite*, after the locality where it was found. As to the admixture of the carbonate with the phosphate, we have been unable to decide whether this was due to a simultaneous deposit of lanthanite with scovillite, or whether the lanthanite is subsequent in formation to the scovillite and a product of its alteration. At all events the carbonate is very intimately and constantly mixed with the phosphate, as we have found no single fragment which would not give off carbonic acid when dissolved in acid. The carbonate, if resulting from the alteration of the scovillite, is not present as a superficial coating, because the fragments when dissolved in acids continue to give off carbonic acid until they are completely dissolved. We take pleasure in acknowledging our indebtedness to Mr. Adam for calling our attention to the peculiar character of this mineral, as well as for his kindness in supplying us with the material for examination.—*American Journal of Science.*

Sheffield Scientific School (U.S.), May 8, 1883.

* CHEMICAL NEWS, (1865), xii., 121 and 183.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Continued from p. 4).

IN these experiments every conceivable precaution was taken to avoid error and ensure accuracy. All weighings were reduced to a vacuum standard: from 70 to 142 grammes of chlorate were used in each experiment; and the chlorine carried away with the oxygen in the first series was absorbed by finely divided silver and estimated. It is difficult to see how any error could have crept in.

Now to combine these different series of experiments.

Berzelius, mean result	60·851	± 0·0006
Penny ,, ...	60·8225	0·0014
Pelouze ,, ...	60·843	0·0053
Marignac ,, ...	60·8392	0·0013
Gerhardt, 1st ,, ...	60·8757	0·0020
,, 2nd ,, ...	60·9487	0·0011
Maumené ,, ...	60·791	0·0009
Stas, 1st ,, ...	60·8428	0·0012
,, 2nd ,, ...	60·849	0·0017
General mean, from all nine series, representing forty experiments..	60·846	± 0·00038

This value is exactly that which Stas deduced from both of his own series combined, and gives great emphasis to his wonderfully accurate work. It also finely illustrates the compensation of errors which occurs in combining the figures of different experimenters.

Similar analyses of silver chlorate have been made by Marignac and by Stas. Marignac's figures I have not been able to find,† and Stas gives but two experiments. The following are his percentages of oxygen in silver chlorate :‡

25·081
25·078

Mean, 25·0795 ± 0·0010

For the direct ratio between silver and chlorine there are seven available series of experiments. Here, as in many other ratios, the first reliable work was done by Berzelius.‖

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Since all the calculations were finished I have secured a copy of Marignac's figures. They are as follows; the third column gives the percentage of O in $AgClO_3$:—

24·510	gramme	$AgClO_3$ gave	18·3616 AgCl	25·103
25·809	,,	,,	19·3345 ,,	25·086
30·306	,,	,,	22·7072 ,,	25·074
28·358	,,	,,	21·2453 ,,	25·082
28·287	,,	,,	21·1833 ,,	25·113
57·170	,,	,,	42·8366 ,,	25·072
			Mean ...	25·088 ± 0·0044

The introduction of these figures into the subsequent calculations could not produce any appreciable result. They would practically vanish from the general mean. However, they serve here as confirmation of Stas's work.

‡ Aronstein's Translation, p. 214.

‖ Thomson's "Annals of Philosophy," 1820, v. 15, p. 89.

He made three estimations, using each time twenty grammes of pure silver. This was dissolved in nitric acid. In the first experiment the silver chloride was precipitated and collected on a filter. In the second and third experiments the solution was mixed with hydrochloric acid in a flask, evaporated to dryness, and the residue then fused and weighed without transfer. One hundred parts of silver formed of chloride :—

132·700
132·780
132·790

Mean, 132·757, ± 0·019

Turner's work* closely resembles that of Berzelius. Silver was dissolved in nitric acid and precipitated as chloride. In experiments one, two, and three the mixture was evaporated and the residue fused. In experiment four the chloride was collected on a filter. A fifth experiment was made, but has been rejected as worthless.

The results were as follows; in a third column I put the quantity of AgCl proportional to 100 parts of Ag :—

28·407	grains Ag	gave	37·737	AgCl	132·844
41·917	,,	,,	55·678	,,	132·829
40·006	,,	,,	53·143	,,	132·837
30·922	,,	,,	41·070	,,	132·818

Mean, 132·832 ± 0·0038

The same general method for dissolving silver in nitric acid, precipitating, evaporating, and fusing without transfer of material, was also adopted by Penny.† His results for 100 parts of silver are as follows, in parts of chloride :—

132·836
132·840
132·830
132·840
132·840
132·830
132·838

Mean, 132·8363, ± 0·0012

In 1842 Marignac‡ found that 100 parts of silver formed 132·74 of chloride, but gave no available details. Later,‖ in another series of determinations, he is more explicit, and gives the following data: The weighings were reduced to a vacuum standard.

79·853	grms. Ag	gave	106·080	AgCl	Ratio, 132·844
69·905	,,	,,	92·864	,,	132·843
64·905	,,	,,	86·210	,,	132·825
92·362	,,	,,	122·693	,,	132·839
99·653	,,	,,	132·383	,,	132·844

Mean, 132·839 ± 0·0024

The above serres all represent the synthesis of silver chloride. Maumené§ made analyses of the compound, reducing it to metal in a current of hydrogen. His experiments make 100 parts of silver equivalent to chloride :—

132·734
132·754
132·724
132·729
132·741

Mean, 132·7364 ± 0·0077

By Dumas* we have the following estimations :—

9·954	Ag	gave	13·227	AgCl	Ratio, 132·882
19·976	,,	,,	26·542	,,	132·869

Mean, 132·8755 ± 0·0044

Finally, there are seven determinations by Stas,† made with his usual accuracy and with every precaution against error. In the first, second, and third, silver was heated in chlorine gas, and the synthesis of silver chloride thus effected directly. In the fourth and fifth silver was dissolved in nitric acid, and the chloride thrown down by passing hydrochloric acid gas over the surface of the solution. The whole was then evaporated in the same vessel, and the chloride fused, first in an atmosphere of hydrochloric acid, and then in a stream of air. The sixth synthesis was similar to these, only the nitric solution was precipitated by hydrochloric acid in slight excess, and the chloride thrown down was washed by repeated decantation. All the decanted liquids were afterwards evaporated to dryness, and the trace of chloride thus recovered was estimated in addition to the main mass. The latter was fused in an atmosphere of HCl. The seventh experiment was like the sixth, only ammonium chloride was used instead of hydrochloric acid. From 98·3 to 399·7 grammes of silver were used in each experiment, the operations were performed chiefly in the dark, and all weighings were reduced to vacuum. In every case the chloride obtained was beautifully white. The following are the results in chloride for 100 of silver:—

132·841
132·843
132·843
132·849
132·846
132·848
132·8417

Mean, 132·8445, ± 0·0008

We may now combine the means of these seven series, representing in all thirty-three experiments. One hundred parts of silver are equivalent to chlorine, as follows :—

Berzelius	32·757	± 0·0190
Turner	32·832	0·0038
Penny	32·8363	0·0012
Marignac	32·839	0·0024
Maumené	32·7364	0·0077
Dumas	32·8755	0·0044
Stas	32·8445	0·0008

General mean, 32·8418 ± 0·0006

Here, again, we have a fine example of the evident compensation of errors among different series of experiments. We have also another tribute to the accuracy of Stas, since this general mean varies from the mean of his results only within the limits of his own variations.

The ratio between silver and potassium chloride, or, in other words, the weight of silver in nitric acid solution which can be precipitated by a known weight of KCl, has been fixed by Marignac and by Stas. Marignac,‡ reducing all weighings to vacuum, obtained these results. In the third column I give the weight of KCl proportional to 100 parts of Ag.

4·7238	grms. Ag	=	3·2626	KCl	69·067
21·725	,,		15·001	,,	69·050
21·759	,,		15·028	,,	69·066
21·909	,,		15·131	,,	69·063
22·032	,,		15·216	,,	69·063
25·122	,,		17·350	,,	69·063

Mean, 69·062 ± 0·0017

* *Phil. Trans.*, 1829, 291
† *Phil. Trans.*, 1839, 28.
‡ *Am. Chem. Pharm.*, 44, 21.
‖ See Berzelius's Lehrbuch, 5th Ed., vol. iii., pp. 1192, 1193.
§ *Ann. de Chim. et de Phys.*, (3), 18, 49. 1846.

* *Ann. Chem. Pharm.*, 113, 21. 1860.
† Aronstein's Translation, p. 171.
‡ See Berzelius's Lehrbuch, 5th edition, vol. iii., pp. 1192, 1193.

Stas' experiments upon this ratio may be divided into two series.* In the first series the silver was slightly impure, but the impurity was of a known quality, and corrections could therefore be applied. In the second series pure silver was employed. The potassium chloride was from several different sources, and in every case was purified with the utmost care. From 10·8 to 32·4 grammes of silver were taken in each experiment, and the weighings were reduced to vacuum. The method of operation was, in brief, as follows:—A definite weight of potassium chloride was taken, and the exact quantity of silver necessary, according to Prout's hypothesis, to balance it was also weighed out. The metal, with suitable precautions, was dissolved in nitric acid, and the solution mixed with that of the chloride. After double decomposition the trifling excess of silver remaining in the liquid was determined by titration with a normal solution of potassium chloride. One hundred parts of silver required the following of KCl:—

First Series.

69·105
69·104
69·103
69·104
69·102

Mean, 69·1036 ± ·0003

Second Series.

69·105
69·099
69·107
69·103
69·103
69.105
69·104
69·099
69·1034
69·104
69·103
69·102
69·104
69·104
69·105
69·103
69·101
69·105
69·103

Mean, 69·1033 ± 0·0003

Now, combining the three series, with their thirty experiments, we get the following:—

Marignac..	69·062	± 0·0017
Stas, 1st series	69·1036	0·0003
Stas, 2nd series	69·1033	0·0003

General mean, 69·1032 ± 0·0002

The quantity of silver chloride which can be formed from a known weight of potassium chloride has also been determined by Berzelius, Marignac, and Maumené. Berzelius† found that 100 parts of KCl were equivalent to 194·2 of AgCl; a value which, corrected for weighings in air, becomes 192·32. This experiment will not be included in our discussion.

(To be continued.)

Researches on Mesitylene.—MM. Robinet and Colson.—The authors describe a new glycol, and prove that the mesitylene dichloride and dibromide obtained by the action of chlorine and bromine upon the vapour of mesitylene are identical with the dihydrochloric and dihydrobromic ethers of this glycol.—*Comptes Rendus.*

* Aronstein's Translation, pp. 250-257.
† *Pogg. Ann.*, viii., 1. 1826.

OBITUARY.

THE LATE MR. PETER SPENCE.

WE regret to have to announce the death of Mr. Peter Spence, which took place on July 5th, at his residence, Erlington House, Seymour Grove, Old Trafford. Mr. Spence, who was in his 78th year, had been in failing health for several months. The death of Mrs. Spence, his second wife, in February, was a severe shock to him. From that time, although not suffering from any specific disease, he gradually lost strength, and ultimately passed quietly away. Mr. Spence was a man who, beginning life with few advantages, was able by sheer force of character to raise himself to a position of wealth and influence. For a long time he had held a leading place in the business in which when young he embarked, and which in some respects he revolutionised. He gave much of his time to the study of the leading social questions of his day, especially those having a sanitary or industrial bearing, and in helping on social reform he found a congenial sphere of public usefulness.

Mr. Spence was born at Brechin, in Scotland, and began his business life at Perth. His education, although good of its kind, was limited in its range and included little or no scientific teaching. He, however, early showed a liking for chemistry, and whilst at Perth he applied his spare time to the study of that branch of science. In the year 1834 he began business at Greenwich as a chemical manufacturer. Subsequently he took the control of some chemical works near Carlisle, and here in 1845, by a patient course of experimenting, he discovered a process for the manufacture of alum from the refuse shale of collieries and the waste ammoniacal liquor of gasworks. This discovery was the foundation of his success. After patenting his process, he left Carlisle and came to Manchester, choosing this city because the raw materials of his manufacture could here be readily obtained, and because the district supplied a good market for the finished article. One practical result of his invention was to lower the price of alum from 30 to 40 per cent, but it did not prove an immediate financial success. A good many difficulties had to be overcome and some heavy losses sustained before much benefit was reaped by the inventor. The Pendleton Alum Works, by successive extensions, have now become the largest in the world, being capable of turning out 200 tons of alum per week, besides other products. In addition to these works Mr. Spence also established chemical works at Goole and at Birmingham. Since he introduced his process the manufacture of alum, as of chemical substances generally, has undergone many changes. A number of these changes were the result of Mr. Spence's own researches. He took out between 50 or 60 patents, nearly all of which were for improvements in chemical processes. He was, indeed, looked upon as one of the best practical chemists of the day, and he obtained this distinction by hard work in the laboratory. In the course of his scientific experiments Mr. Spence found amongst other things that steam of 212° F. could be made to raise the temperature of saline solutions to their boiling-point, however high that might be. Thus a solution of acetate of potash might be readily raised by open steam to a temperature of 336° F. A paper on the subject was read by Mr. Spence at the Exeter meeting of the British Association. His statement was doubted by the chemists present until by actual experiment he proved the truth of what he had advanced. About ten years ago the circumstances of an accident on one of the English railways, which seemed to indicate that cold increased the liability of cast-iron to fracture, led him to undertake a series of experiments on cast-iron bars at zero (Fahr.), and he found that instead of being weakened by reduction of temperature the resistance of the iron to fracture was, in fact, increased some 3 per cent. A similar investigation

made at the time by Dr. Joule gave substantially the same results. The purification of the air of towns was a subject which he had studied. He brought before the Manchester Literary and Philosophical Society, of which he was an active member, a scheme for purifying the air of a town by conducting the smoke of all house and factory chimneys along the sewers and up a column some 600 ft. in height, at which altitude he believed the law of the diffusion of gases would operate to prevent any injury to public health. The author firmly held to the theory that when smoke is completely consumed it is only the mechanical impurities which are removed, and that sulphuric acid, the element most injurious to life, remains. If his scheme did nothing else it helped to attract attention to the means of carrying away that most insidious domestic poison, sewer gas. Amongst Mr. Spence's patents is one for a furnace for calcining sulphur ores and condensing the sulphurous acid produced. This furnace has been adopted at the great copper works at Swansea, where the ores were previously burnt in the open air, to the great detriment of vegetation.

Mr. Spence was an earnest advocate of temperance. A total abstainer from his youth, there was probably no cause in which he took a keener interest. He was for a number of years a vice-president of the United Kingdom Alliance, and was largely instrumental in bringing Mr. Murphy, the founder of the Blue Ribbon Army, to Manchester. To the temperance cause, as to all public objects of which he approved, he gave most liberally. His private gifts of a charitable nature were also upon a very generous scale.

The deceased gentleman's first wife was Miss Agnes Mudie, of Dundee, and of their family of eight children seven are now living.—*Manchester Examiner.*

NOTICES OF BOOKS.

*The Coal-Tar Colour Works of the Company, formerly Meister, Lucius, and Brüning, of Höchst on the Main, in a Sanitary and Social Point of View.** By Dr. Grandhomme. Heidelberg: Gustav Köster.

The effects of the coal-tar colours upon the health of those who manufacture them, who dye or print with them, or who wear goods thus dyed or printed, have been the subject of much random comment. The most exaggerated statements have been circulated concerning their dangers to public health. Dyes which do not exist at all, and others which could not by any means produce the alleged colours upon textile goods, have been charged with occasioning the most unlikely diseases. It is true that these ghastly stories bear upon the very face proof that they have been concocted by persons grossly ignorant of the subject, and invariably break down when carefully sifted. Still there is not merely scope, but need for the work before us, and for the prolonged and close investigations upon which it is founded.

These researches could scarcely have been conducted anywhere else in so satisfactory a manner. The Höchst Colour Works employ 672 men in the actual manufacture of the colours, exclusive of engineers, stokers, mechanics, packers, carters, &c., as well as of clerks and very numerous laboratory staff. There is thus a fairly broad field for observation. The products manufactured are very numerous. In addition to nitro-benzol and aniline we find mention of rosaniline (the free base), magenta, aniline blues and violets, malachite green, resorcine, eosine, erythrosine, the naphthaline yellows, oranges, browns, reds, &c., and alizarin. An important feature is that the workmen do not change about from one of these departments to another, and are expressly forbidden to enter any part of the factory save that where their regular duty lies. These regulations, whatever their primary motive, render it possible to make accurate observations on the physiological action of every kind of colour. Further, the health of the workmen is made the subject of an especial and very minute kind of book-keeping, which space does not allow us to describe, but which renders it easy to trace the health of any given workman, the cases of illness in any department, their nature, symptoms, treatment, and result.

If, after all this careful examination, it is found that the health of the workmen is fairly good, and that the majority of the cases of illness occurring are not of a specific nature connected with the physiological action of the dye-wares manufactured, we may surely conclude, *a fortiori*, that persons who come in contact with these colours in a much slighter degree are little likely to be injuriously affected. Again, any injurious properties of the raw materials, such as nitro-benzol, aniline, naphthaline, phenol, &c., though they concern the manufacturer, do not tell upon the dyer or the wearer. Magenta, *e.g.*, is made from aniline, but aniline no more exists in magenta than does farmyard manure in the grain of wheat.

The poisonous properties of nitro-benzol have been established, in addition to careful experiments upon animals, by 47 cases recorded in medical literature, fourteen of which, or nearly one-third, terminated fatally. Among the twenty-four men employed at Höchst in the nitro-benzol house there have been in the last four years 108 cases of illness; but of these forty were due to wounds, burns, &c., and only in five cases did the well-marked symptoms of "nitro-benzolismus" appear.

Aniline, again, is unquestionably poisonous. Among the twenty-nine men employed in the aniline-house there have been in the last four years 171 cases of illness: of these sixty-one were due to mechanical injuries, and eighteen arose from the specific action of aniline. None of these proved fatal, and the average duration of illness for each patient was 11½ days. No derangement of vision has been complained of, and, contrary to the assertion of Laborve, no epileptic convulsions have been observed.

Magentas, made by the arsenic process and not duly purified, are recognised as poisons; but the symptoms recorded are those produced by arsenic, which in some inferior magentas has even exceeded 8 per cent. On the other hand, not merely observations, but direct experiments made with pure magenta—such as that made at Höchst, where Coupier's process is employed—prove its innocence. Eczema does not occur in colour works. Bergeron, Clouet, Husson, and Bertel performed experiments upon frogs, dogs, rabbits, &c., and the two first-mentioned authorities upon their own persons. In no case was diarrhœa or colic observed, and especially albuminuria was absent.

Of the fifty-two men employed in the Höchst magenta-house eleven had worked there from six to ten years, and five from eleven to eighteen years. Yet in no case was there a decrease in the weight of the body, or tendency to diarrhœa or a disturbance of the urinary secretion. The inside of the mouth was constantly reddened by the finely-divided colouring-matter inhaled, much of which would be ultimately swallowed. Yet repeated samples of their urine, as voided on Saturday evening, were found perfectly free from albumen.

The author has fed rabbits and fowls upon oats and barley dyed with magenta so as to contain 1 per cent of colour. No morbid phenomena could be traced. Even subcutaneous injection gave merely negative results.

The preparations from the residues of magenta-melt, such as maroon, phosphine, grenadine, &c., are harmless if arsenic is absent. When the arsenic process is used they contain more of the poison than does magenta, and especially grenadine may prove very dangerous. Its occasional use in the concoction of wine is therefore highly objectionable.

As regards the blue colours there has occurred in the

* Die Theerfarben-Fabriken der Actien Gesellschaft Farbwerke, vormalo Meister, Lucius, und Brüning, zu Höchst am Main, in sanitärer und socialer Beziehung.

last four years among the thirty workmen only one case of anilinism.

In the violet- and the green-houses there have occurred no cases of specific disease, though two of the workmen in the latter department have been employed there for fifteen years. Experiments with both these classes of colours upon animals gave negative results.

Resorcine is a decided, though not very powerful poison.

In the eosine department a special disease was observed —*Hyperhydrosis localis*. Nevertheless rabbits fed with barley coloured with eosine and erythrosine remained unaffected. The finished eosine does not seem to be the cause of this curious disease in the workmen, since those engaged in packing the colour are not affected, though their hands are constantly brought in contact therewith. The author suggests that washing in strong chloride of lime may be the cause; at least this affection has become both rarer and less intense since the use of strong solutions of this agent has been prohibited. In this disease the fingers become painfully sensitive, and the secretion of sweat is increased to such an extent that it falls off in drops, whilst chinks, and in some cases abscesses, appear in the palms.

In the naphthol- and orange-houses no special disease is mentioned, naphthaline being formidable only in the state of hot vapours.

No special diseases were observed in the alizarin department.

In summing up the results Dr. Grandhomme compares the mortality among the Höchst workmen with that in the army. In the latter it is 5 per 1000, in the former 4·2, which is the more favourable as 77 per cent of the workmen are over the age of 25, at which the German soldier leaves the army.

It has been found that the use of alcohol reduces the power of the constitution to bear the action of aniline. Hence applicants for work are rejected if on medical examination they are found to have the appearance of drunkards, or if evidence is obtained that they are given to intoxication. No alcoholic drinks are allowed to be brought into the establishment, and any workman arriving in a state of insobriety is dismissed.

There is appended to the book a very copious bibliography of memoirs in medical, &c, journals, and of independent works on the subject.

We must pronounce Dr. Grandhomme's treatise exceedingly valuable to aniline colour manufacturers, to sanitary officials, and to the medical profession in general. It will, we hope, frustrate the attempts made to get up a panic concerning this class of dyes.

Lectures on Practical Pharmacy. By Barnard S. Proctor, formerly Lecturer on Pharmacy at the College of Medicine, Newcastle-on-Tyne. Second Edition. London: J. and A. Churchill.

In this edition the author has largely increased the Index, added certain tables, and inserted various pieces of information calculated to be useful. He has pointed out in what directions the pharmacist may most best turn his attention.

In his introductory lecture he remarks that "materia medica, therapeutics, chemistry, and botany, combined into one art formerly constituted pharmacy, but these sciences gradually becoming separate the term Pharmacy is now applied to such ill-defined and unclaimed ground as has not yet been appropriated by any of these more abstract sciences." We may here be permitted to express our regret that in England, unlike what obtains in the rest of the civilised world, the members of the pharmaceutical profession have elected to call themselves "chemists" instead of "pharmacists."

The first or "general" portion of the work deals with general subjects,—the operations of solution, crystallisation, precipitation, filtration, &c., as viewed with especial reference to pharmaceutical requirements. The second portion treats of officinal, or, as it is now called, official pharmacy.

In the lecture on spirit of wine it appears that pharmacists still retain the somewhat clumsy habit of expressing the strength of a sample, not by its percentage of absolute alcohol, as is done by technical chemists, but by its being so-and-so many degrees above or below "proof." We venture to suggest that this system has a præscientific character about it, scarcely in accord with the present age.

The chapter on dispensing contains much homely but sound advice which students will do well to assimilate. The remarks on reading prescriptions, begun in this and continued in the next chapter, are gravely suggestive not only to the general public, but to chemists other than pharmaceutical. Looking over the cautions given and referring to the lithographed fac-similes of prescriptions appended we may be allowed to wonder that so few sick men are poisoned downright, and that so few dispensing chemists are accused of manslaughter. The responsibility thrown upon the latter is, indeed, unjustly heavy. We can only regard the traditional method of writing prescriptions as a survival of the unfittest, and an instance of unreasoning conservatism. The frequent abbreviations, the use of Roman numerals, and the mediæval symbols for ounces, drachms, &c., are as if intended to create mistakes. One of the most needful features in the much-talked of Medical Reform Bill would be the suppression of these follies. Haste on the part of the physician can be no excuse, since the Roman numerals take more time to write than their Arabic equivalents.

Notes on Qualitative Analysis, Concise and Explanatory By H. J. H. Fenton, M.A., F.I.C., F.C.S., Demonstrator of Chemistry in the University of Cambridge Cambridge: University Press. London: C. J. Clay and Son.

The author of this manual seeks "to direct, and if possible to enforce, attention to the *rationale* of each operation performed and the nature of each reaction which takes place." He complains of a tendency existing among students to regard chemical analysis as a mere routine of mechanical operations, overlooking its scientific aspect.

The work contains, firstly, an account of the principal reactions of twenty-two of the more common metals; then of twenty-nine of the more common acid radicles. Next follow analytical tables, substantially the same as those met with in the ordinary manuals, but so arranged as to dispense with cross references. Lastly follow the reactions of some of the more common organic bodies, introduced for the convenience of medical students. The reactions of the tartrates, citrates, oxalates, and acetates have, however, been given among those of the acid radicles.

We note that, in the table of contents, the sulphocyanogen compounds are referred to as sulpho-cyan*ates*; under the reactions of iron we read both of potassium sulpho-cyan*ate* and potassium sulpho-cyan*ide* and ferric sulpho-cyan*ide*; under cobalt, also, we have mention of potassium sulpho-cyan*ide*. When giving the behaviour of the acid radicles with reagents the author speaks of sulpho-cyan*ates*. In the analytical tables we find the same fluctuating nomenclature. We should suspect that some students may possibly feel confused by this variation in name, and may suppose that two distinct compounds are in question. At the foot of page 9 is a note concerning the yellow ammonium sulphide commonly used in laboratories. The same note is substantially repeated at the foot of page 55.

The book is arranged and printed in such a manner that the instructions and precautions given cannot escape the eye of the student, and if there is still room for an elementary treatise of the kind it may claim a fair position.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 26, June 25, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 15.

Relations of Induction with Electro-dynamic Actions, and a General Law of Induction.—M. Quet.—A mathematical paper, not admitting of useful abstraction.

Maxima and Minima of the Extinction of Phosphorescence under the Influence of the Ultra-Red Radiations.—Henri Becquerel.—The author, after referring to his recent memoirs (*Comptes Rendus*, Jan. 7th and April 23rd of the present year), and to the observations of his father, E. Becquerel (*La Lumière Ses Causes et Ses Effets*, tome i.), states that the red and ultra-red rays act upon phosphorescent substances as does an elevation of temperature; when these substances are previously rendered luminous, these radiations provoke its extinction by encouraging the emission of light so that we see appear first a positive and then a negative image of the ultra-red spectrum. The phenomenon varies in different substances, and presents certain interesting phases. Beside the general phenomena of temporary excitation and extinction produced by the ultra-red radiations which present maxima and minima peculiar to each substance, we observe profound modifications in the effects obtained, depending on the physical state of the bodies, either on their state of phosphorogenic excitement, or on the nature of the incident radiations.

Automatic Impression of Telephotic Despatches.—Martin de Brettes.—The light, concentrated by means of a lens, is thrown upon a selenium element forming a portion of the circuit of the local battery which contains the coil of the electro-magnet motor of the receiver.

Thorium Sulphate.—Eug. Demarçay.—This paper will be inserted in full.

A Base derived from Crotonic Aldehyd.—Alph. Combes.—The author has obtained an oxygenated base from crotonic aldehyd by dissolving this compound in anhydrous ether, cooling to -20°, and saturating the liquid with dry ammoniacal gas. The compound obtained has a distinctly alkaline reaction, and forms a well crystallised salt with hydrochloric acid, and a double salt with platinum chloride.

Observations on Panary Fermentation.—M. Mousette.—In opposition to M. Chicandard (*Comptes Rendus*, May 28th, 1883), the author pronounces the presence of alcohol in fermented bread-paste an established fact.

Moniteur Scientifique, Quesneville. July, 1883.

Industrial Society of Mulhouse.—Chemical Committee, Session May 9th, 1883.—This Society was engaged with the conditions of prizes offered, and with opening sealed packets of old dates, the contents of which are no longer of interest.

Session June 13, 1883.—The principal paper read was a note on the direct fixation of indigo upon cloth, which will be inserted in full.

M. H. Kœchlin exhibited specimens of woollen cloth, dyed respectively with cochineal and alizarin, and exposed to the light for three months. The cochineal was scarcely altered, but the shades dyed with cochineal had faded perceptibly, and that the more the greater the proportion of tin present.

Industrial Society of Rouen.—A catalogue of prizes offered for researches, chiefly in connection with the tinctorial arts.

Review of Biological Chemistry.—G. de Bechi and H. Gal.—A series of extracts from German journals, relating principally to physiological and medical subjects.

The Future of the Manufacture of Chlorine.—Dr. F. Hunter.—From the *Journal of the Society of Chemical Industry*.

Industrial Review.—M. Gerber.—A list of the specifications of chemical patents, chiefly German, to which are added Dr. Armstrong's paper on the oil of turpentine and its sophistications, and Mr. L. Carpenter's memoir on the conversion of oleic acid into palmitic acid, from the same source.

Patents concerning Colouring-Matters.—An account of the specifications of German patents for the preparation of dyes.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., April, 1883.

The only chemical paper in this issue is a version of Mr. Walter Weldon's memoir on the present state of the alkali industry, read before the Society of Chemical Industry.

May, 1883.

Report presented by M. Bérard on behalf of the Committee of the Chemical Arts, on M. Houdart's Method for the Determination of Plaster in Wines.—The process adopted is a modification of that of MM. Poggiale and Marty, and is carried out as follows:—Into a series of numbered test-tubes 5 c.c. of the wine are put by means of a graduated pipette, and by means of another pipette fitted with a cock there are added successively known quantities of a standard solution of barium chloride capable of precipitating respectively 1, 2, 3, 4, and 5 grms. of sulphate. Each is raised to a boil, and after having been allowed to settle a few drops of the standard barium solution is added. If, then, a fresh turbidity appears in tube 2, in which 2 grms. have been precipitated, but not in No. 3, in which 3 grms. have been precipitated, it appears that the wine contains more than 2 and less than 3 grms. of plaster per litre. We take, then, in another test-tube 10 c.c. of the wine, and add the quantity of barium solution corresponding to 5 grms. This quantity, for a double volume of wine answers to 2·5 grms. plaster per litre. By means of the verification above described it is found whether the plaster is more or less than 2·5 grms. per litre. With a little experience it is easy to appreciate a fourth of a grm. per litre—an approximation sufficient for commercial purposes.

Lecture on the Artificial Reproduction of Organic Substances.—E. Jungfleisch.—An account of the artificial production of urea, alizarin, vanillin, &c.

Determination of Phosphoric Acid in Arable Soils.—P. de Gasparin.—Taken from the *Comptes Rendus*, January 29, 1883.

Cosmos Les Mondes. Tome v., No. 8, June 23, 1883.

Combination-heats of the Soluble Compounds of Nickel.—Dr. D. Tommasi.—The author gives the combination-heat of nickel sulphate as determined experimentally and as calculated by his law, and subjoins the calculated combination-heats of a number of nickel compounds.

Revue Universelle des Mines, de la Metallurgie, &c., No. 2, March and April, 1883.

Determination of Alkalies in Silicates.—W. Hempel.—From the *Zeitschrift f. Analyt. Chemie.*

New Volumetric Method of Determining Manganese in Steel, Cast-Iron, Ferro-Manganese, &c.—E. Raymond.—The method in question is recommended as easy, expeditious, and accurate. It consists in precipitating all the manganese in the state of peroxide, dissolving it in a ferrous solution so as to bring back the manganese to the manganous state, and determining volumetrically, by means of potassium permanganate, the quantity of ferrous salt which has been converted into ferric. The method of rapidly precipitating manganese peroxide is peculiar. If we act upon cast-iron or steel with nitric acid and potassium chlorate in certain proportions, and boil the mixture, the manganese is completely precipitated in the state of peroxide insoluble in nitric acid, but retaining a small quantity of ferric oxide. Suppose that we have a sample of steel or manganiferous cast-iron containing less than 7 per cent of manganese. Three grammes are treated in a small flask with 40 c.c. of nitric acid, of sp. gr. 1·20, added little by little. The liquid is stirred, and ultimately heated to complete solution. It is withdrawn from the fire, and 15 grammes potassium chlorate are added, and then 20 c.c. of nitric acid at sp. gr. 1·40. It is boiled for about fifteen minutes, until the escape of chlorine ceases; all the manganese is found thrown down as peroxide; hot water is added, the mixture is filtered, and the precipitate washed with boiling water. To dissolve the manganese peroxide thus obtained we measure exactly 50 c.c. of an acid solution of ferrous sulphate, made up with 40 grammes ferrous sulphate to 750 c.c. water and 250 c.c. sulphuric acid (full strength). The 50 c.c. are poured into the flask in which the sample has been dissolved, and to which a little peroxide adheres, and it is then poured upon the precipitate and the filter in a Berlin-ware capsule. The manganese peroxide dissolves very readily, transforming its equivalent of ferrous sulphate into ferric sulphate. The liquid is then diluted to 100 or 150 c.c. for the next operation. We then take a solution of permanganate formed by the same proportions as are used in determining iron by the process of Margueritte (5·65 grammes of the crystalline salt per litre of water), and determine its standard exactly. By means of this liquid we determine volumetrically the quantity of ferrous sulphate remaining in the solution of manganese. We take then 50 c.c. of the original solution of ferrous sulphate diluted as above, and determine the total ferrous salt. The difference between the two determinations corresponds to the ferrous salt which has been peroxidised by the manganese peroxide. The quantity of iron thus peroxidised multiplied by 0·491 gives the quantity of manganese contained in the portion operated upon. In the case of a steel or cast-iron containing but little manganese it is convenient to dissolve the peroxide in 25 c.c. only of the ferrous solution. Small Gay-Lussac burettes may then be used in the titration of only 0·010 metre internal diameter, and graduated into $\frac{1}{10}$ c.c., which allows of great exactitude in the determination. For a spiegeleisen not more than 1 gramme of the sample should be taken, and for a ferro-manganese 0·3 gramme.

MISCELLANEOUS.

The late Mr. William Spottiswoode.—At a meeting of the Royal Institution on the 2nd inst., it was resolved: "That the Managers of the Royal Institution desire to record their profound regret for the recent death of Mr. William Spottiswoode, who for so many years, as Manager, Treasurer, or Secretary, rendered such eminent services to the Royal Institution. In him the world has lost a man of the first distinction. While his own researches have done much to advance the progress of mathematical and physical science, his encouragement and wise counsels to other workers have also been of the utmost value. As President of the Royal Society he has fulfilled the duties of his high office with conspicuous ability and success. As one of the heads of the important public establishment, with which his family has been long connected, it is known that he afforded an admirable example of what should be the conduct of one placed in a position of so much responsibility and authority. His interest in all that tends to promote the general welfare of humanity was equally remarkable. No good work of a public nature, which came within the range of his means, was ever allowed to proceed without his aid and sympathy. His character presented a remarkable combination of intellectual strength and fine moral qualities. His judgment was unerring, and of so discreet a kind, as to ensure for it a deference which was universal. In private life his kindliness, courtesy, and general culture endeared him to his friends, and engaged the regard of all who were so fortunate as to become acquainted with him. The public tribute paid to the memory of the late President of the Royal Society, by his interment in Westminster Abbey, is a striking proof of the general esteem in which he was held. It rests for the Managers to express their deep sympathy with Mrs. Spottiswoode, and the other members of Mr. Spottiswoode's family, under their heavy bereavement."

A Modification of Noack's Method for Preparing Carbonic Oxide.—Leonard P. Kinnicutt.—In the *Berlin Berichte*, vol. xvi., p. 75, E. Noack shows that carbonic oxide can be obtained by passing carbon dioxide over zinc-dust. The idea that the same gas might be more conveniently made by heating carbonates directly with zinc-dust, led me to try a series of experiments with magnesite. I found that when powdered magnesite, mixed with twice its weight of zinc-dust, is placed in a copper retort and heated so that the bottom of the retort is nearly surrounded by the flame, a gas is immediately given off, which, after the first five minutes, is nearly pure carbonic oxide. For the first five minutes the gas is a mixture of carbonic oxide, carbon dioxide, and in case the substances were not perfectly dry, a little hydrogen. In place of a retort hard combustion tubing can be used. An analysis of the gas, when given off at the rate of about four bubbles a second, collected directly from the retort and measured over mercury, gave the following result:—

Vol. of gas 152·5. $P = 583·4$. $t = 4°$. Cor. $V = 115·4$.

After absorption of CO_2 by KOH:—

Vol. of gas 150·0. $P = 588·8$. $t = 5°$. Cor. $V = 114·7$.

Per cent $CO_2 = 00·61$.

I have undertaken the study of the decomposition of other carbonates, but as a method for preparing carbonic oxide the above is in every way satisfactory; the manner in which the gas is given off resembling that of oxygen when made from potassium chlorate, with the advantage that the evolution is more easily controlled.—*American Chemical Journal.*

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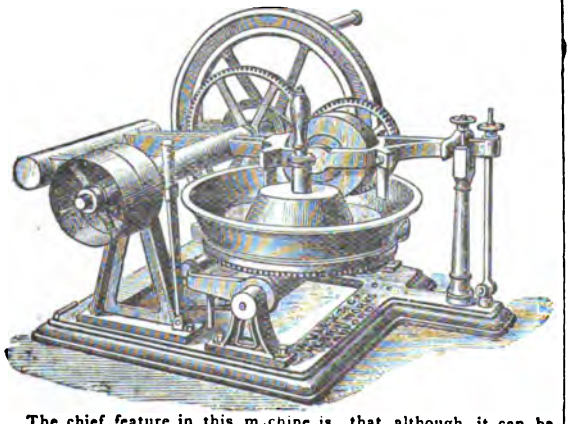

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1234.

THE CONVERSION OF CARBON MONOXIDE TO CARBON DIOXIDE BY ACTIVE (*i.e.*, NASCENT) OXYGEN.

By Dr. ALBERT R. LEEDS.

In the early part of the year 1879 I was led by certain theoretical considerations to regard it as eminently probable that carbonic oxide would be converted by nascent oxygen into the highest stage of oxidation, and that by properly devising the nature of the experiments, and adequate precautions in the execution of their details, the direct oxidation of carbon monoxide to dioxide by nascent oxygen at ordinary temperatures could be demonstrated. Repeated trials amply justified these anticipations. The final experiment, some account of which will be found in the *Journ. Amer. Chem. Soc.*, i., 232, was performed as follows:—A 5-litre jar, containing 5 sticks of phosphorus and a little water, was filled with 2500 c.c. of carbonic oxide, and the remaining space with air. The carbonic oxide was generated from potassium ferrocyanide and sulphuric acid, and washed with water, caustic potassa, and barium hydrate. On transferring it to the jar, it was again washed through a similar train of purifiers, a final U-tube filled with barium hydrate solution remaining pellucid, proving absence of any trace of carbon dioxide. The air was purified in the same manner. At the expiration of eighteen hours, the gases remaining above the moist phosphorus in the jar were drawn first through a moist cotton filter, then through a potassium iodide solution, and finally through two baryta waters. The faint rose colouration which the iodide solution struck with starch water, was found on titration to correspond to 0·04 m.grm. ozone in the total volume of gas drawn over. The last baryta water was absolutely pellucid, the first had absorbed 14 m.grms. carbonic acid. The carbonic acid estimation was made by decomposing the barium salt, and weighing the carbonic acid evolved, for fear that some traces of oxides of phosphorus might have escaped from the purifiers, and entered into combination with the baryta.

Later on, further details as to precautions employed in these experiments will be given in connection with the adverse criticisms to which they have been recently subjected.

Somewhat later in the same year a related field of experiment was entered upon. This was to determine conclusively whether or no the triatomic molecule of oxygen was capable of effecting what the individual atom of oxygen, at the moment of dissociation of the molecule of oxygen, had been demonstrated to be capable of doing.

It should be premised that the decompositions and recombinations which occur when phosphorus is oxidised at the expense of and with simultaneous reduction of the oxygen molecule, are complicated in their nature. An operose determination of the factors of this reaction (*Journ. Amer. Chem. Soc.*, vi., 146, and ii., 37) has shown that it may be represented by the equation—

$$aP+bO+cN+dH_2O = a^1P_2O_3+a^2P_2O_5+b^1O_3+c^1(NH_4NO_3)+c^2(NH_4NO_2 \text{ subsequently oxidised to } NH_4NO_3)+d^1H_2O_2.$$

The actual values of the coefficients would depend, as was shown in another place, upon the temperature at which the reduction of the oxygen molecule is effected, and the values, *a*, *b*, *c*, *d*, of the members of the equation. But the important point established was that ozone, hydrogen peroxide, and nitro-compounds of ammonia were always formed, and their quantities always bore a certain relation to one another. Moreover, that the explanation of these facts could be found only in the supposition of the formation of active oxygen, and the subsequent generation of ozone was no more an essential feature of the reaction than the contemporaneous and invariable production of hydrogen peroxide and ammonium nitrite and nitrate.

In some earlier experiments, which had been performed with great care, by Profs. Remsen and Southwith (*Amer. Journ. Sci.*, iii., 11, 736), the conclusion had been arrived at, that carbon monoxide was not oxidised to carbonic dioxide by ozone.

As above stated, I was induced to renew the investigation (*Journ. Am. Chem. Soc.*, i., 450), inasmuch as certain preliminary experiments which I had performed had shown that carbonic oxide might undergo conversion into carbonic acid, under the same circumstances which brought about the oxidation of the oxygen molecule to the state of ozone. These were notably two:—1st. The oxidation of carbonic oxide by nascent oxygen evolved in an atmosphere of moist air over phosphorus, as detailed above. 2nd. The simultaneous formation of carbonic acid and ozone in a mixture of carbonic oxide and oxygen subjected to the influence of the silent electrical discharge. Without pausing to rehearse *in extenso* the experiments by which this latter point was established, it will suffice to state that a quantitative determination resulted in showing, that after 1½ litres of carbonic oxide had been submitted to the action of the silent discharge, in company with oxygen, 0·0271 grm. (misprinted 0·0271 m.grm., *loc. cit.*) of carbon dioxide had been formed.

Moreover, I had been enabled by the use of a modified form of Siemens ozoniser, to make use of large volumes of oxygen, raised to a higher degree of ozonation than the ozonised gas hitherto employed, and I thought that the theoretic importance of the subject warranted the institution of a fresh attempt to discover whether, with ozone of this degree of concentration, no oxidation of carbon monoxide occurred.

The actual experiment was conducted as follows:—Oxygen, previously freed from every trace of carbon dioxide, was ozonised by passage through an ozonising battery to the extent of 72 m.grms. of ozone per litre. It was then passed in excess, together with carbon monoxide likewise completely purified, through a tube 1 metre in length, which was placed *beyond* the ozoniser. But although the current of mingled ozonised oxygen and carbon monoxide was made to flow with a very slow current, and though the experiment was continued for many hours, the baryta water, through which the mixed gases finally made their escape, remained entirely pellucid. In other words, oxygen containing a very large percentage of free ozone is not capable of effecting the oxidation of carbon monoxide.

Commenting upon this result, the inference was drawn:—"In this case, the energy of combination of the two bonds, presumably free, of the carbon monoxide molecule, appears to be of less valency than the energy with which any one atom in the ozone molecule is retained by the other two. In the two former instances" (the oxidation of carbon monoxide by nascent oxygen, and the generation of carbon dioxide in a mixture of carbon monoxide and oxygen submitted to the silent discharge) "the ozone molecules are in the process of formation, and in the pre-existent stage (in which the oxygen molecule undergoes dissociation), the liberated oxygen atom is seized upon by the unsaturated carbonic oxide."

Subsequently (*Journ. Amer. Chem. Soc.*, ii., 34) these views were still further generalised in an essay which had for its object the quantitative investigation of the various factors in the complicated reactions connected with the oxidation of phosphorus in moist air. It had previously been shown (*Ibid.*, i., 8) that the amount of ozone produced by the oxidation of phosphorus under given cir-

cumstances is constant for any particular temperature, and consequently the generation of ozone may be graphically represented by a curve, the production at 6° C. being *nil*, rising to a maximum at 24° to 25° C., and then rapidly diminishing as the temperature approaches 44°, the melting-point of phosphorus.

As additional proof of the constancy of the phenomena occurring in the oxidation of phosphorus in moist air, it was established in the progress of this essay that the amounts of ozone and hydrogen peroxide bear a constant relation to one another, and to the air passed over. A similar proposition holds true of the phosphoric and phosphorous acids, and of the ammonia and nitric acid—the amounts of the latter bodies being in the ratio requisite to form ammonium nitrate. Later on it was shown that, neglecting the small amounts of hydrogen peroxide which were held back by the wash-waters through which the escaping gases pass, the ratio of the hydrogen peroxide generated was to that of the ozone as something over one to three under the conditions of that particular experiment.

These various results caused me again to reiterate the wide generalisation which had been brought forward in the earlier articles concerning the production of ozone under the conditions studied—that it was connected with the uneven quantivalences of the elements taking part in the reaction. "If this hypothesis be true, then we should anticipate the development of ozone whenever oxidation of a perissad occurred at temperatures compatible with the stability of the ozone molecule, even at the temperature of combustion of hydrogen; this is supposed by C. Than to be the case. He explains in this manner the presence of the ozone, which he states he has detected in the combustion of hydrogenous substances generally, and its absence in the combustion of carbon."

"In entering into new combinations, the oxygen molecules must undergo temporary resolution into their constituent atoms. These, while *en route* to take up new positions in other combinations, and animated by their atomic energy, or energy of the nascent state, may either oxidise the oxygen molecule, or the nitrogen molecule, or the molecule of water. In the first place, ozone would be produced; in the second, regarding water as the basic body and NNO as the nitrile, there might be formed, as Hunt has indicated, ammonium nitrate; in the third, hydrogen peroxide."

This recapitulation is here given in order to recal the gradual evolution of the hypothesis of the necessary existence of active or nascent oxygen, as a body distinct from ozone, in order to explain observed phenomena. According to these views the oxidising effect of palladium-hydrogen, as noted by Hoppe-Seyler, at a later period in the history of these researches,* was a particular case of the oxidation of a perissad (in this case, hydrogen) at a temperature especially compatible with the stability of the ozone molecule. The intervention of nascent hydrogen, or active hydrogen, is not needed to explain the production of hydrogen peroxide when hydrogenium or palladium-hydrogen comes in contact with water. Hydrogenium is a perissad metal endowed with the most eminent deoxidating or reducing powers. When it reduces the molecule of oxygen, a temporary resolution of the molecule into its constituent atoms must necessarily take place. In other words, hydrogenium stands in the same relation to the production of hydrogen peroxide as phosphorus does when oxidised in presence of moist air. Like the phosphorus it directly reduces the oxygen molecule, and sets free the oxygen atom. This active oxygen so formed is the efficient cause of all the subsequent phenomena. It starts the series of chemical changes, and is the principal and all-important factor, as related to which and resulting from which the generation of the ozone, hydrogen peroxide, and ammonium nitrate and nitrite, are three correlative and necessarily dependent, but inevitably and indissoluble connected, consequences. According to this hypothesis, the generation of ozone is not the central fact around which the possible formation of active oxygen and the other phenomena are grouped, but it is a secondary phenomenon, and is of no more importance, so far as the theory of the reaction is concerned, than the simultaneous development of hydrogen peroxide, and, in presence of nitrogen, of nitrogen compounds.

The foregoing history of previous investigations is given in order to render intelligible the attitude in which I stood with regard to the statements recently made by I. Remsen and E. H. Keiser in a paper "On the Conduct of Moist Phosphorus and Air towards Carbon Monoxide" (*Amer. Chem Journ.*, iv., 454). It will be further necessary only to state that these views are not the same as those advanced by Hoppe-Seyler, as may be seen from different induction which I drew from Hoppe-Seyler's own experiments. For in his original experiments this investigator did not suspect the necessary presence of peroxide of hydrogen, as an indispensable factor in the reactions observed. Subsequently (*Ber. der Deutsch. Chem. Gesell.*, xiv., 976) I pointed out that this must be the case, and on performing the experiment quantitatively determined the amount of peroxide formed. The only reasons for previously anticipating, and actually performing the experiments confirmatory of, the presence of hydrogen peroxide, were the theoretical considerations connected with the development of active oxygen above enunciated. Ignoring these results, M. Traube in a later issue of the *Berichte* (xv., p. 659) brought forward the formation of hydrogen peroxide under these circumstances, as his own observation, and has founded upon this production of hydrogen peroxide a hypothesis, concerning the validity of which, and concerning the experimental verification of the experiments upon which it is based, I shall defer writing until the publication of a subsequent article.

After recounting certain preliminary experiments, the crucial one, by which Remsen and Keiser hold that they conclusively established the non-conversion of carbon monoxide to dioxide in the presence of moist air and phosphorus, and so far as the evidence afforded by this experiment is concerned, the non-existence of active oxygen, is stated as follows:—

"An apparatus was finally constructed in which these were entirely excluded, or, at least, so protected that the ozone could not possibly reach them. Although a number of different forms of apparatus were tried, we need only describe that which we finally decided upon as the best. This consisted of a flask of from 3 to 4 litres capacity, provided with a doubly perforated cork stopper. Through this there passed one glass tube reaching to the bottom of the flask, and another reaching only half way. Outside the flask the shorter tube was connected with the apparatus intended to remove the carbon dioxide from the air, and the longer tube was bent twice at right angles, and then passed through the stopper of a U-tube about 8 inches high. Between this U-tube and a second like it, connection was made by means of a doubly-bent glass tube. In the flask there were placed usually two or three sticks of phosphorus each 3 or 4 inches long, and enough pure water to somewhat more than fill the neck when the flask was inverted. The U-tubes were filled with ignited asbestos, and there was then added some mercury so that when the tubes were inverted, in which position the entire apparatus was placed when in use, the metal covered the corks with a layer from three-quarters of an inch to an inch in thickness. The connecting tubes passed, of course, in each case through the layer of mercury. The vessel containing the clear baryta water was also connected with the last U-tube by means of a mercury joint similar to those above described. The baryta water was protected from the action of the air by placing before it a small U-tube containing potassium hydroxide, and this last tube was connected with an aspirator. Before connecting the bulbs containing the baryta water, air freed from carbon

* "Activation of Oxygen by Nascent Hydrogen," *Ber. der Deutsch. Chem. Gesell.*, xii., 1551.

dioxide was drawn slowly* through the apparatus. On now connecting with the baryta water bulbs no precipitate was formed. Even on allowing the air to remain in contact with the moist phosphorus for periods varying from one to twelve hours, no carbon dioxide could be detected. This experiment was tried over and over again at different temperatures, but always with the same result.

"About one-third of the air in the ozone flask was now replaced by carbon monoxide from which all dioxide had been scrupulously removed. The mixture was allowed to stand for some hours, and then drawn through the baryta-water bulbs, when no precipitate was formed. This experiment was repeated a number of times with the same result. In some cases the air and carbon monoxide were drawn together slowly for a long time over the moist phosphorus, but this made no difference in the result. So frequently was the experiment performed, so great were the precautions against error, and so undeniably negative were the results, that, in spite of the explicit statements of Leeds and of Baumann, we do not hesitate to say that carbon monoxide is not oxidised when exposed to the action of air and moist phosphorus. It follows, of course, from this that the action of air and moist phosphorus on carbon monoxide furnishes no evidence in favour of the view that there is an active condition of oxygen distinct from ozone."

The authors further say:—"Leeds's error is easily explained. In the first place he took no special precautions to protect the corks from the action of the ozone, and in the second place he passed the gases through a filter of moist cotton for the purpose of removing 'oxides of phosphorus.' Now cotton, as it is usually met with, yields carbon dioxide when subjected to the influence of ozone, so that the carbon dioxide noticed by Leeds was probably the result of the action of ozone on the cotton or the oily substances which always adhere to it."

With regard to this explanation it may be said that at a very early stage in experimenting with ozone, the observer is compelled to note the destructive action of ozone on corks and rubber connections, and either to eliminate them altogether or to boil the corks in paraffin and cover them with the same, both of which last precautions were taken in the present instance. The action of the very attenuated form of ozone obtained from phosphorus is excessively slight, as I knew when speaking of its employment in connecting ozone apparatus at a later date (*Journ Amer. Chem. Soc.*, ii., 150):—"Paraffin does not perfectly withstand the action of ozone, being slowly decomposed with the formation of carbonic acid. In the course of long-continued use, the paraffin joints employed by the author in connecting the ozonising elements of his large electrical ozoniser (*Ibid.*, i., 440) were destroyed, and had to be renewed from time to time. The amount of action on the joints was progressive, the paraffin connection between the first and second ozonising element requiring to be changed very seldom, while that between the eleventh and twelfth elements needed frequent renewal." . . . "In experimenting with ozonised air, containing so small an amount of ozone as that employed in the investigation described in the present article" (ozonation by phosphorus), "the connections may be made of paraffin without entailing serious error, but in researches of greater nicety, where not merely the relative but the absolute amounts of ozone have to be determined, paraffin connections cannot be employed."

The cotton employed to remove the oxides of phosphorus —and I should have added in this as I have in other places, that cloud of vesiculated peroxide of hydrogen (the antozone of Schönbein and other authors), which by its passage through *water*, &c., without absorption so puzzled the earlier experimenters,—this cotton, I repeat, was not the common cotton wool of commerce. It had been previously treated with alkali so as to remove all fatty matters, and then repeatedly exhausted with water and dilute acid, until its reaction was neutral, all soluble matters removed, and a white fibrous material as near pure cotton fibre as possible had been obtained.

Still, in performing a crucial experiment, it was certainly important to eliminate every surface of contact except those of glass and water. Even mercury, or any other possibly oxidisable metallic surface, is objectionable, on account of a possible deozonation of the very minute amounts of ozonised air, which are formed by ozonation with phosphorus.

But before stating the details of this experiment, it will be well to narrate that performed by Baumann (*Zeit. f. Physiol. Chem.*, v., 250), who subsequently to my own labours effected the conversion of carbon monoxide to dioxide at ordinary temperatures by means of active oxygen. He writes—"A slow stream of air free from carbonic acid was conducted through a flask containing moist phosphorus; thence into a second flask containing a mixture of 3 vols. oxygen and 1 vol. carbonic oxide, and finally through baryta water. The last remained perfectly clear after the gas had been passed through it for six hours, and after every trace of carbonic acid had been previously removed from the apparatus. On the other hand, when the mixture of carbonic oxide and oxygen was conducted into the flask containing phosphorus, and in which there must have been, according to our proposition, active oxygen, an altogether different result followed: the baryta water presently became turbid, and in an hour threw down an abundant precipitate of barium carbonate.

Commenting upon the above, our critics say:—"Nothing is said about stoppers or rubber connections, and it is safe to assume that, in the apparatus used by Baumann, ozone came in contact at some points with organic matter. Hence the formation of carbon dioxide is easily accounted for." . . . . Whatever the sources of error in Baumann's experiment may have been, we are confident that a repetition with the precautions taken by us will show him this —his conclusion is wrong."

It is not our duty, but that of the writer impugned, to inform us whether this confidence in his having neglected to take the most obvious and indispensable precautions in the conduct of his experiments is well founded.

My own repetition of the original investigation was performed as follows:—

Seven 6-inch sticks of clean phosphorus were placed in a 10-litre flat-bottomed bottle, with an accurately fitting glass stopper, the bottle filled with air- and carbonic acid-free distilled water, and inverted in a small pneumatic trough, likewise filled with distilled water. Carbon monoxide, which had been made several days previously, and allowed to stand over distilled water in a glass gas-holder, was purified by passing through a long train of purifiers similar to those employed in connection with carbon determinations in steel, and to which additional wash-bottles containing caustic potash and baryta water had been added. Whatsoever carbon dioxide was present originally was so thoroughly removed that the baryta water in the last wash-bottle remained absolutely limpid, on passing sufficient carbonic oxide into the ozonator bottle to fill it nearly one-half. An equal quantity of air, after passage through the same train of purifiers, and equally well freed from the dioxide, was then introduced into the ozonator. While the bottle was still inverted in the trough the tight-fitting stopper was introduced, and it was then reverted, sufficient water being allowed to remain in the jar half to cover the phosphorus. The bottom of the bottle being flat, on distributing the sticks by gentle shaking they were partly and uniformly submerged, and exposed to the largest possible amount of deoxidising surface.

The ozonator still standing in the water of the trough was then brought to a temperature of 24° C. by heating the trough, and kept at this temperature for six days. The antozone cloud (*i.e.*, suspended hydrogen peroxide) produced the first day gradually subsided, and the atmosphere

* This operation requires care and constant attention. The phosphorus not unfrequently takes fire. In one case in our experience it took fire after having stood quietly and unmolested for several hours.

became perfectly clear. The very gradual disappearance of these clouds—in part due to the gradual interaction of ozone and hydrogen peroxide with the formation of water and ordinary oxygen, and in part due to the mechanical difficulty with which the peroxide when once brought into a condition of aëriform, and probably vesicular, suspension goes into solution in water—strongly countenances the supposition that they are mainly, and probably entirely, suspended hydrogen peroxide. The energy with which the oxides of phosphorus unite with, and are absorbed by, water, makes it an untenable supposition that they could, even if formed, remain for any length of time suspended in the atmosphere, so that whilst in my earlier experiments it seemed easier to suppose the clouds to be oxides of phosphorus than a non-volatile body like hydrogen peroxide in a state of aëriform suspension, yet later on the latter explanation was proved experimentally to be the correct one.

At the expiration of six days the atmosphere contained in the bottle was withdrawn by the following manipulation, all contact with organic surfaces, except for a few seconds when the atmosphere remaining in the bottle came in contact with paraffin, being impossible :—

The glass stopper was removed, a cork saturated with paraffin, through which the necessary connecting tubes passed, inserted, and instantly the mouth of the bottle plunged beneath the surface of a mercury trough. This inversion carried the phosphorus and water down, so that the water covered the paraffined cork. Then the cork was quickly loosened, and the aspiration, being connected with the series of connecting tubes, but no air being allowed to enter, mercury was drawn up into the flask sufficient to cover the paraffined surface. The cork being forced back again, remained covered with mercury during the remainder of the experiment.

The glass tubes were so bent that no breaks or connections in them occurred between the atmosphere contained in the baryta water of the last wash-bottle, through which the air was aspirated to take the place of the atmosphere contained in the ozonator, and the baryta water contained in the wash-bottle, through which the mixture of carbon oxides and air remaining at the close of the experiment was finally passed. No break, except in the ozonator itself; and here it occurred above the surface of the water, the displacing air entering near the bottom, the gaseous products passing out from the upper portion of the jar. To prevent the diffusion backwards into the last wash-bottle of the entering current of any of the atmosphere in the ozonator, a bulb was blown on one of the lower curves of the entrance tube so as to form a mercury valve. Such a precaution was not necessary on the escaping tube, its end dipping directly beneath the surface of baryta water. This baryta water was again protected from the action of the atmosphere by being connected with another wash-bottle containing neutral solution of potassium iodide. On now aspirating a current of air freed from carbonic acid through the apparatus, an abundant white precipitate formed in the collecting flask, and eventually a white crust formed on the sides of the entering tube beneath the surface of baryta water. When the atmosphere of the ozonator had been completely changed and no further precipitation occurred, the contents of the wash-bottle were transferred to a carbonic acid apparatus, and the percentage estimated in the ordinary manner. The air used in aspirating was freed from carbonic acid likewise. The weighings were as follows :—

Potash bulbs after decomposition and aspirating	43·8295 grms.
Potash bulbs before do. do. ..	43·8140 „
Increase in weight (carbon dioxide)..	0·0155 grm.

There was no difficulty in obtaining a qualitative test for carbon dioxide from the white crust adherent to the entrance tube, and the amount of which should properly form a part of the 15·5 m.grms. actually weighed. On cutting off this tube with its white crust, dropping it into a test-tube, and allowing a drop of acid to run down the crust, it was energetically decomposed with the formation of bubbles of gas, and a drop of lime water properly supported on the under side of a glass cover stopping the exit of the test-tube, became turbid.

Objections to the fact of the above experiment, being conclusive as to the production of 15·5 m.grms. and upwards of carbon dioxide :—

1st. That there was an interval during which at the close of the experiment the atmosphere of the ozonator was in contact with the paraffined cork. Admitting that the air in this experiment was sufficiently charged with ozone to decompose paraffin, yet, as a matter of fact at the close of the experiment, no ozone was present. The potassium iodide in the final wash-bottle, after acidulation, contained no free iodine. And, as it should properly be objected that this negative result is inconclusive, on account of the combination of nitrogen and ozone in presence of alkaline liquid to a nitrate, it should also be remembered that this reaction would not have been sufficiently energetic to detain every trace of residual ozone. In my earlier experiment, in which 5 litres of air had been used, and the amount of carbon dioxide formed was 14 m.grms., the amount of residual ozone was only 0·04 m.grm.

2nd. The water contained sufficient ozone in solution to decompose the paraffin submerged beneath in the instant of time before being covered with mercury. This is eminently improbable, since the establishment of the fact that ozone is soluble at all was a very laborious matter, ane was only successful after many long-continued qualitative tests made with very highly ozonised oxygen (*Journ. Amer. Chem. Soc.*, 1, 220).

The same remark opplies to the possibility of the dissolved ozone being converted into ordinary oxygen in contact with the mercury covering the paraffined cork.

3rd. It may be said that even if we grant that carbon dioxide was formed, it might have resulted from the combined action of ozone and hydrogen peroxide, both of which oxidants were certainly present. But inasmuch as neither of these bodies alone effects the oxidation of carbon monoxide (and Prof. Remsen's own experiments are conclusive as to this point), and inasmuch as their mutual action is not of an oxidising but of a reducing character, both bodies being reduced, the one to oxygen, the other to water, the above supposition is untenable.

I hold, therefore, that the fact of the oxidation of carbon monoxide to dioxide by air over moist phosphorus, has been established by a rigid quantitative and qualitative analysis. Moreover, that this oxidation is, as I have always held it to be, the proof of the existence of active oxygen, as a body antecedent to the formation of ozone.

The essential feature in my own interpretation of the phenomena studied is that active oxygen is always formed when reduction of the oxygen molecule occurs at temperature compatible with the stability of the ozone molecule. That nascent hydrogen is not essential to this reduction is shown by the reduction being effected by phosphorus, in which case the intervention of nascent hydrogen does not occur. Hydrogen and phosphorus are probably only the two most conspicuous of the bodies capable of reducing the oxygen molecule at ordinary temperatures, and whilst both these are perissads and this fact appears to be connected with the production of active oxygen, I am not able in the present state of experimental knowledge to say that the perissad nature of the reducing element is an essential feature of the formation of active oxygen. As I have repeatedly stated, the essential part of my hypothesis is the reduction of the oxygen molecule at a temperature compatible with the stability of the ozone molecule. Even without chemical intervention, the silent electrical discharge will do this, and form primarily active oxygen and secondarily ozone. That such is the case is

shown by the formation of carbonic dioxide when a mixture of carbon monoxide and oxygen are submitted to the silent discharge.

Stevens Institute of Technology,
April 15th, 1883.

METHODS OF ANALYSING SAMARSKITE

AND THE OTHER COLUMBATES CONTAINING EARTHY OXIDES, BY THE AGENCY OF FLUORHYDRIC ACID; AND OF DISSOLVING COLUMBITE AND TANTALITE BY THE SAME ACID.—ON THE SEPARATION OF THORIA FROM THE OTHER OXIDES.—QUANTITATIVE ESTIMATION OF DIDYMIUM OXIDE IN ITS MIXTURES WITH OTHER EARTHY OXIDES.

By J. LAWRENCE SMITH, Louisville, Ky.

(Concluded from p. 15).

As it has been necessary to use letters to indicate the various groups of constituents of this mineral, they will be stated in a list, for easy reference.

A—The portion of samarskite soluble in fluorhydric acid.

B—The portion of samarskite insoluble in fluorhydric acid.

C—The mixed oxalates of the earths from samarskite.

D—The earthy oxides insoluble or dissolved with difficulty by the sulphate of potassium or sodium.

From the time that samarskite was discovered until I undertook the examination of the mineral as it was found in Mitchel county, N.C., the earths from the ignited oxalates were considered to be the oxides of the cerium group and yttria group, and in my researches made in 1876 and 1877, while I referred to one of these oxides as cerium oxide, in a footnote* I stated that there were grounds for belief that the oxide so called was not cerium oxide, as it was completely soluble in a very dilute solution of nitric acid.

A little later, by repeated precipitation of this oxide (as prepared from samarskite) with sodium sulphate I obtained an oxide, the sulphate of which is absolutely insoluble in a concentrated solution of the sulphate. The oxide of this was completely soluble in very dilute nitric acid. In many respects it resembled cerium oxide. Among them it did not furnish any absorption ray in the spectrum, but its complete solubility in very dilute nitric acid was a marked distinction between it and cerium oxide. For this reason I considered it a new oxide and called it mosandrum. The atomic weight of the oxide was made out to be 109 (O=16).

M. Marignac, however, as well as Prof. Delafontaine, was inclined to regard the oxide as terbia. The properties of this latter earth were never clearly understood, yet as far as I have been able to make them out I considered it to differ from what I had called mosandrum. Not having any absorption ray, it is not so easy to decide upon as upon most of the earthy oxides.

The study instituted upon the earths coming from samarskite opened a new field of investigation upon the earths of the cerium and yttrium groups, especially among those which give marked and decided absorption rays. As yet they cannot be separated in a pure state in sufficient quantity for a complete chemical study, at least so far as my information at the present time goes.

Prof. Delafontaine, of Chicago, has done some excellent work on these earths, among which he considers that he has discovered two vessels that are new, philippium† and decipium. In regard to the first, the spectroscopic and other characteristics are well defined, so much so that those chemists and physicists who have examined it, as MM. Marignac, Soret, and Lecoq de Boisbaudran, have no doubt upon the subject. As regards decipium* the spectroscopic examination of Soret and Lecoq de Boisbaudran has not as yet furnished us with any positive decision, as far as my information extends at the present time. M. Delafontaine, however, feels satisfied about it.

In addition to the above, M. Marignac has separated another, working, however, on gadolinite and euxinite, which he calls ytterbium,† and L. F. Nilson another, which he calls scandium,‡ and believes to be associated with the ytterbium of Marignac. It is determined by spectroscopic examination of a somewhat complicated nature. I would here state that most of these new earths have only been made out by a very small quantity, sometimes less than a gramme, the spectroscopic work being done by the most skilful observers.

The use of the spectroscope in studying the earths requires great care, and sometimes the presence of a very minute quantity of some foreign substance may lead to wrong conclusions. Thus the presence of traces of uranium caused Sorby to mistake zirconia for a new oxide that he called jargonia, and some similar cause induced Delanfontaine‖ to consider that there was a marked difference between the didymium oxides of cerite and samarskite, didymium oxide of cerite being a mixture of different earths. Soret,§ however, showed that the didymium oxide from samarskite, as furnished him by Marignac, was the same as that from the oxide from cerite. Lecoq de Boisbaudran came to the same conclusion from the oxide I had furnished him as coming from samarskite. A still more curious fact is that, in some experiments I had made in connection with Lecoq de Boisbaudran, a peculiar treatment of pure didymium oxide by acids so altered the most important absorption ray furnished in the spectrum of that earth as to destroy its characteristics.¶

Up to the present time the following earths have been found in samarskite. I give the list as made out by Delafontaine, with the exception of mosandrum, which he does not recognise:—

Yttria,	Thoria,
Erbia,	Oxide didymium,
Terbia,	Oxide cerium,
Philippia,	Mosandria,
Decipia,	

The proportion of each of these earths in the 14 per cent of earths it is impossible to state. As regards the thoria it is about 0·50 of the mineral. The oxides of cerium and didymium exist only in traces.

The method of separating most of these earths is by fractional precipitation with oxalic acid, or by some alkali as employed by myself. Operating with the ignited nitrate is used in other instances, but in whatever manner the separation is attempted it is attended with difficulty and greatly reduces the quantity of the residuary oxide which is sought for.

It is the insoluble precipitate D that furnishes the difficult problem of quantitative analytical chemistry, and several earths of yet undefined character have been more or less perfectly separated. I will give some of my own labours in that direction.

Many interesting results have been worked out by Marignac, of Geneva, and Delafontaine, of Chicago; but the slow, tedious processes that have to be employed will delay those labours very much.

The method by which I made some imperfect operations on the oxalate C is as follows:—The powder is dried, ignited, and weighed. It has a pale yellow colour, and consists of several earthy oxides. It is completely soluble in dilute or strong nitric acid. The solution of it in the acid is evaporated to the consistency of thick syrup, thus driving off nearly all the free acid. To this syrupy mass, before

* *Amer. Journ. Science*, May, 1877.
† *Comptes Rendus*, 1878, 86, 559.

* *Comptes Rendus* 1878, 86, 632.
† *Ibid.*, 1879, 87, 578.
‡ *Ibid.*, 645.
‖ *Ibid.*, 1877, 85, 634,
§ *Ibid.*, 1878, 86, 422.
¶ *Ibid.*, 1878, 86.

it solidifies,* about 50 c.c. of a concentrated solution of sulphate of potassium or sodium (lately I have used the sodium salt altogether), and mixed into the mass. It gives at first a clear solution. To this is added three or four grms. of small crystals of the sulphates, the whole stirred frequently and allowed to stand for 24 hours. A precipitate soon begins to form, and at the end of the time is quite abundant. It is now thrown into a filter and thoroughly washed with a concentrated solution of potassium or sodium sulphate, but at no time will the filtrates be entirely free from a trace of the insoluble double sulphate. This precipitate is called D. The filtrate is supposed to contain yttria and erbia. To it is added oxalic acid or ammoninm oxalate, the precipitated oxalate burnt, re-dissolved and re-precipitated† by the oxalate, then burnt, and after very thorough ignition, weighed. This oxide is then dissolved in dilute sulphuric acid, evaporated carefully to dryness, and heated nearly to red heat, until its weight is constant. This is noted, and from the weight of the oxide and that of its sulphate, the relative proportion of yttria and erbia is estimated by the formula of Bahn and Bunsen :—

$$x = 4{\cdot}906A - 2{\cdot}4540\ B.$$

x = the erbia contained in A; the oxides, which give B, the sulphates.‡ The first precipitate by the sodium sulphate, washed with a solution of the same, is dissolved in hydrochloric acid, and first precipitated as oxalates, then changed into oxides by ignition. It is in this oxide that I searched for mosandrum by repeated precipitation with sodium sulphate and re-conversion into oxides, when I obtained an oxide as dark as cerium oxide, dissolved in minute quantity in sodium sulphate and perfectly soluble in very dilute nitric acid, after 30 minutes' contact.

The insoluble double sulphates D precipitated from the solution of the earths may contain any or all of the other cerium oxides and thoria. This is dissolved in water containing a little chlorhydric acid, by the application of heat; the solution is then nearly neutralised by ammonia and precipitated by oxalic acid or oxalate of ammonia, the precipitate is burnt, re-dissolved in nitric acid and re-precipitated by the oxalate, which is well burnt and weighed.

This was originally supposed to be the cerium group of earths, but when rubbed up with a little water it is completely dissolved§ in dilute nitric acid (1 acid to 100 water), in from 15 to 30 minutes, showing the absence of cerium oxide, or if present only to the extent of a mere trace.

To test this fact still farther, I precipitated the earth from its nitric acid solution by caustic soda, adding just enough to make the solution alkaline, then added 3 to 4 grms. of caustic soda, and adding water enough to make the mixture 50 c.c.; it is quite thick from the gelatinous precipitate. A stream of chlorine gas is now passed slowly through the mixture for 2 or 3 hours, in the manner recommended by M. Mosander for separating cerium oxide from its associated earths. But none of the indications of colour peculiar to cerium oxide are manifested, but all the oxides are taken into solution except a small quantity of a white gelatinous precipitate. This precipitate was collected on a filter and washed, detached from the filter and dissolved by means of a few drops of sulphuric acid, evaporated to dryness, heated to drive off the excess of acid, and when dissolved in a little cold water and examined, was found to be thoria.‖ It was afterwards precipitated by ammonium oxalate, burnt, and weighed, and represented 0·80 per cent. This is a new and valuable method of separating thoria, which will be treated of in another part of this paper.

The fact of the absence of cerium oxide led to a thorough examination of the D precipitate; for the Russian variety of samarskite contains cerium. But to do this I had to make the study upon a much larger quantity of the earths than that obtained from 5 grms. of the mineral, which contain only about 4 per cent. of the D oxides, so that what follows is based on the use of ample material obtained from several kilogrms. of the mineral.

In this large operation I did not use platinum vessels for the first treatment, but lead vessels, the decomposing vessels being of the capacity of four litres, and capable of working more than one kilogrm. at a time, and the mineral was sufficiently divided by passing it through a wire sieve with ½ m.m. meshes (less than 30 minutes being required to prepare a kilogrm. for the action of the fluorhypric acid). The mineral is placed in the lead capsule and 750 c.c. of water poured upon it, then one kilogrm. of fuming fluorhydric acid is added by degrees, and the mixture stirred with a lead rod until the violence of the action ceases. Then a second kilogrm. of acid is added and stirred in. The capsule is now placed on a water-bath and heated, with occasional stirring, for two or three hours, when the action is complete, and we proceed as already described with the 5 grms.

When the insoluble fluoride of the earths are obtained I find the following the best way of changing them to oxalates. 250 grms. of the dry fluorides rubbed up in a mortar and placed in a platinum capsule, and then 250 c.c. of concentrated sulphuric acid are added without water; the mixture stirred and heated over the flame until nearly dry, and after cooling, dissolving in water and uranium oxide farther oxidised by nitric acid. After filtration the whole is diluted to about 5 litres, boiled by a current of steam, nearly neutralised and then precipitated by 225 grms. oxalic acid dissolved in one litre of water. The oxalates thus obtained are operated with as already described for the separation of yttria, using either potassium sulphate or sodium sulphate. The latter has certain advantages in large operations. The thoria of the earth is with that part which is difficultly soluble in sodium sulphate.

Separation of Thoria.

The separation of this earth from the others with which it is usually associated is attended with more or less difficulty and uncertainty. These earths are of the cerium group, for the concentrated solution of potassium sulphate precipitates the thoria along with these earths. One of the best methods is considered to be that by sodium hyposulphite, but the use of it did not enable me to decide upon the presence of thoria when I made the examination for my mineralogical paper on the "Columbic Acid Minerals of the United States,"* while the method about to be described makes it easy of detection and quantitative separation; so much so that I am satisfied that by means of it the metal thorium will be found to be more generally diffused than it has been supposed to be.

If thoria be precipitated from a solution of any of its salts by the fixed alkalies, and the gelatinous precipitate added to a little water containing four or five times its weight of caustic potash or soda, and a current of chlorine has passed through it for any length of time, none of the thoria will be taken into solution; and if the other earths usually associated with thoria be present, the same result will take place as regards the thoria, but all the other earths will be dissolved with the exception of the cerium oxide. These facts have been fully verified by a special set of experiments, The thoria in the samarskite was estimated in this way,† and no analytical result could be more satisfactory, sufficient care being taken to pass chlorine

* We are supposed to be operating with one or two grms. of the mineral.

† This second precipitation is always necessary when we are analysing these earths, and the first solution contains potash and soda.

‡ In the use of this method of operation it was supposed that cerium oxide and yttria could be easily separated from each other by the bisulphate of potassium and sodium, and the oxides remaining in solution were yttria and erbia, but more recent research has shown its defective character, and it is no longer adapted to furnish any good method.

§ This is based on the supposition that there is no other oxide present.

‖ The cold solution when heated was changed into a mass of delicate silky crystals so remarkably characteristic of thoria.

* *Am. Journ. of Science*, 13, May, 1877.

† As already described where treating of the absence of cerium oxide in the samarskite.

gas through the solution long after it is supposed to be saturated. Two or three hours is not too long where ½ to 1 grm. of the mixed oxides is operated with.

Separation of the thoria from the mixed earths by ammonia.—When thoria has to be separated from a large quantity of its associate earths, the chlorine method is long, and the insoluble part has to be separated and treated two or three times before complete separation is accomplished. I accomplished this by an excellent method, but one not intended to furnish quantitive results like the chlorine method.

Using, say, 50 grms. of the earths separated by the potassium or sodium sulphate, dissolve it in nitric acid somewhat diluted, and concentrate over a water-bath, add the contents of the capsule to about three litres of water, boil by current of steam or otherwise, and, when in a state of ebullition, neutralise by ammonia until only a few flakes remain undissolved; then add by degrees an ammonia solution of known strength and just sufficient to precipitate 6 or 8 grms. of the oxides,* the solution being made to boil violently during the operation. This ebullition is continued for about five minutes. A bulky gelatinous precipitate will be formed which contains all the thoria and a little of the other oxides. This is thrown on a filter and washed. This takes place very slowly. The gelatinous precipitate is dissolved in a dilute solution of sulphuric acid, evaporated to dryness, excess of acid driven off, re-dissolved in cold water. By boiling and evaporation it separates in its well-known form, which, when hot, is separated from the mother-liquor. The sulphate of thorium thus obtained is not perfectly pure, but if wanted for chemical investigations it can be purified by the usual method. This separation clearly arises from the fact that the thoria is less basic than the other earths.

The filtrate from the gelatinous precipitate is treated with oxalic acid, and the precipitated oxalate dried and ignited, giving a salmon-yellow oxide that is further examined by processes to be described. The fact that these earths have only a mere trace of thoria remaining in them is established by the fact that, when 1 grm. of them is treated by the chlorine test for thoria already described, all the oxides are completely dissolved except 4 milligrms. I then recommend this method as one likely to prove useful for the purification of large quantities of the earths containing thoria in small quantity.

The earth from the thoria is of a salmon-yellow colour, its oxalate burns readily, and all tests were applied to discover lanthanum oxide, and only a very doubtful evidence of its presence was obtained. So that, of the three cerium metals, only didymium oxide remained to look for. A nitric acid solution gave the very well-known spectroscopic bands of that metal, but it was impossible to separate it by a chemical process. But by making use of the spectroscopic I think I have approximated to the proportion mixed with the oxides in the following manner:—

Quantitative Estimate of Didymium Oxide by its Absorption Bands.

Make solutions of the oxide of didymium of known strength, and place the solutions in tubes of uniform diameter. Phials of thin glass 1½ c.m. diameter were used. Then take the oxides to be tested, dissolving a known quantity of the oxides in a solution of nitric acid, placing in a tube of the same size as those containing the didymium salt of known strength, compare the solution in the tubes before the spectroscope with the different didymium tubes, and it will be soon seen which one of these latter gives bands corresponding in intensity with the didymium bands in the solution of oxides that are tested; and knowing the exact proportions of oxide in the didymium tube, a good approximate result may be obtained.

I am now making an apparatus, using only one solution of didymium and simply varying at pleasure the thickness of the solution. In this way I estimate that the mixed earthy oxides of samarskite contain less than 0 25 of didymium. As regards the principal portion of the earth separated from the yttria, I consider it as an oxide, or oxide of a new earth, for I cannot reconcile my mind to the idea that it is principally terbia. One of the earths present I call mosandrum, and M. Delafontaine has separated two, philippium and decipium.

Owing to the fact of bodily indisposition I have not been able to continue my researches on these earths.

For the complete quantitative analysis of samarskite, reference is made to labours previously made by myself and others,* with this difference, that in the earthy oxides there is 0·50 per cent of thoria, and the cerium referred to is not that oxide, but other mixed oxides.

* In the present instance I have calculated the amount on the basis of an atomic weight of the oxides of 116 (O=16.

NOTE ON A METHOD OF PREPARING DIQUINOLINE.

By R. C. TRESIDDER.

THE following method was employed for obtaining diquinoline from quinoline:—

Quinoline was converted into its hydrochlorate by heating in a retort with the strongest hydrochloric acid, and distilling off the water. The hydrochlorate of quinoline was then heated with an equal weight of zincic chloride to a temperature of 350° C. for five or six hours, the retort being inverted. The product was transferred to a flask, and treated with strong solution of soda, added in sufficient quantity to re-dissolve the precipitate of zincic hydrate first formed. The mixture was then submitted to distillation with steam to remove unchanged quinoline, which distilled over, leaving a black oily liquid, which solidified on cooling. This black matter was washed with water, and then boiled with a large quantity of alcohol, and the solution filtered whilst hot. The filtrate was decolourised with animal charcoal, and again filtered hot. Diquinoline crystallised out on allowing the solution to cool, and was purified by re-crystallisation from alcohol. The yield was not large, but sufficient to render the method applicable to the production of diquinoline.

A DISTINCTIVE TEST FOR GALLIC ACID.

By SYDNEY YOUNG, D.Sc.

WHEN an aqueous solution of gallic acid is treated with a solution of potassium cyanide, a beautiful red colouration is produced, which, however, disappears after a short time if the liquid is not disturbed. The surface, however, remains coloured, and on tapping the test-tube in which the solution is contained, the superficial coloured portion is driven downwards into the colourless liquid below. If, now, the test-tube is shaken energetically, the colour reappears as at first, but, on standing, the liquid again becomes colourless. This alternate production and disappearance of the beautiful and characteristic red colour may be repeated as many as fifteen or twenty times, the solution finally attaining a permanent brownish yellow colour.

Pure tannic acid gives no colouration with potassium cyanide, but commercial tannic acid invariably contains a certain amount of gallic acid, and therefore the reaction is usually observed, though the colour is only feeble.

A sample of tannic acid, which gave a rather deep colouration with potassium cyanide, was dissolved in water, and to the strong solution about one-third of its volume of ether was added, and the whole shaken

* *Amer. Journ. of Science*, May, 1877.

vigorously. After standing, three layers were formed, as described by Guibourt (*Ann. Chem. Pharm.*, 48, 359).

After evaporation of the upper ethereal layer, the light yellow residue was dissolved in water and treated with potassium cyanide, when the deep red colour due to gallic acid was produced. The middle layer was found to contain a still larger quantity of gallic acid. A drop of the syrupy brown aqueous solution of tannic acid, which formed the lowest layer, when diluted with water and treated with potassium cyanide, gave a much feebler colouration than the original tannic acid. This process of purification was repeated four times, the gallic acid reaction, both in the case of the upper ethereal layer and the syrupy tannic acid solution, becoming weaker each time, until at last the cyanide produced no colouration whatever.

It thus appears that tannic acid free from gallic acid is not coloured by potassium cyanide, which reagent therefore affords by far the most convenient means of distinguishing between those two acids. Moreover, the presence of a very small quantity of gallic acid in tannic acid is indicated by this means.

University College, Bristol, July 12, 1883.

BEHAVIOUR OF CERTAIN ORGANIC COMPOUNDS WITH ROSANILINE SULPHUROUS ACID.

By G. J. SCHMIDT.

THE author's object is to ascertain whether the reaction first observed by H. Schiff, *i.e.*, that aldehyds give a violet colour to a solution of magenta previously decolourised by sulphurous acid, is characteristic of all and especially of the higher alkaloids, and by what other compounds, if any, such a colouration is produced. The reagent is best prepared by passing sulphurous acid into a dilute solution of a salt of rosaniline until the liquid merely retains a faint yellow colouration. It may be preserved for a long time in stoppered bottles. The substances examined by the author behaved as follows with the reagent:—

Acetaldehyd, paraldehyd, and propionaldehyd, even in traces, give an intense red-violet colouration. Isovaleraldehyd and œnanthaldehyd give the colouration less readily. Chloral yields at once a fine colour, whilst chloral hydrate gives no reaction. Butyl-chloral and acroleine produce a violet colour on shaking. Furfurol and benzaldehyd give the colour more readily. Cinnamaldehyd, furfur-acroleine, and furfur-crotonaldehyd give, first, an intense yellow colour, which soon changes to a violet-red. Salicylic aldehyd gives a fine red-violet colour, which, with cuminic aldehyd, appears only after some agitation. Formic acid gives no reaction. Even small quantities of acetone on shaking produce a violet-red colour, but aceto-phenon and benzo-phenon had no action. Among the sugars, glucose, levulose, lactose, and saccharose were tried, and had no effect. Methylic and ethylic alcohols on shaking gave a faint violet colour; propylic and iso-propylic alcohols gave a scarcely perceptible tint. The alcohols with a higher proportion of carbon, the glycols, phenols, and quinone had no effect on the reagent.

Hence it appears that the reaction is characteristic of the aldehyds in general, but that it is also produced by certain simply-composed bodies of the fatty series which stand nearest the aldehyds.—*Zeitschrift für Anal. Chemie.*

Appointment.— Mr. A. Humboldt Sexton, Science Master at the Wedgwood Institute, Burslem, has been appointed Teacher of Chemistry, Physics, and Metallurgy at the Manchester Technical School.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Continued from p. 19).

IN 1842 Marignac† published two determinations, with these results from 100 KCl:—

	192·33
	192·34
Mean, corrected for weighing in air ..	192·26 ± 0·003

In 1846 Marignac‡ published another set of results, as follows. The weighings were reduced to vacuum. The usual ratio is in the third column.

17·034 grms. KCl gave	32·761 AgCl	192·327
14·427 ,,	27·749 ,,	192·341
15·028 ,,	28·910 ,,	192·374
15·131 ,,	29·102 ,,	192·334
15·216 ,,	29·271 ,,	192·370

Mean, 192·349 ± 0·006

Three estimations of the same ratio were also made by Maumené‖, as follows:—

10·700 grms. KCl gave	20·627 AgCl	192·776
10·5195 ,,	20·273 ,,	192·716
8·587 ,,	16·556 ,,	192·803

Mean, 192·765 ± 0·017

The three series of ten experiments in all foot up thus:—

Marignac, 1842	192·260 ± 0·003	
,, 1846	192·349	0·006
Maumené	192 765	0·017

General mean, 192·294 ± 0·0029

These figures show clearly that the ratio which they represent is not of very high importance. It might be rejected altogether without impropriety, and is only retained for the sake of completeness. It will obviously receive but little weight in our final discussion.

In estimating the atomic weight of bromine the earlier experiments of Balard, Berzelius, Liebig, and Löwig may all be rejected. Their results were all far too low, probably because chlorine was present as an impurity in the materials employed. Wallace's determinations, based upon the analysis of arsenic tribromide, are tolerably good, but need not be considered here. In the present state of our knowledge, Wallace's analyses are better fitted for fixing the atomic weight of arsenic, and will, therefore, be discussed with reference to that element.

The ratios with which we now have to deal are closely similar to those involving chlorine. In the first place there are the analyses of silver bromate by Stas.§ In two careful experiments he found in this salt the following percentages of oxygen:—

20·351
20·347

Mean, 20·349 ± 0·0014

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Ann. Chem. Pharm.*, 44, 21. 1842.
‡ "Berzelius's Lehrbuch," 5th edition, vol. iii., pp. 1192, 1193.
‖ *Ann. d. Chim. et d. Phys.* [3], 18, 41. 1846.
§ "Aronstein's Translation," pp. 200-206.

There are also four analyses of potassium bromate by Marignac.* The salt was heated, and the percentage loss of oxygen determined. The residual bromide was feebly alkaline. We cannot place much reliance upon this series. The results are as follows:—

28·7016
28·6496
28·6050
28·7460

Mean, 28·6755, ± 0·0207

When silver bromide is heated in chlorine gas, silver chloride is formed. In 1860 Dumas† employed this method for estimating the atomic weight of bromine. His results are as follows:—In the third column I give the weight of AgBr equivalent to 100 parts of AgCl.

2·028 grms. AgBr	gave 1·547	AgCl	131·092
4·237 ,,	3·235	,,	130·974
5·769 ,,	4·403	,,	131·024

Mean, 131·030 ± 0·023

This series is evidently of but little value.

But the two ratios upon which, in connection with Stas's analyses of silver bromate, the atomic weight of bromine chiefly depends are those which connect silver with the latter element directly and silver with potassium bromide.

Marignac,‡ to effect the synthesis of silver bromide, dissolved the metal in nitric acid, precipitated the solution with potassium bromide, washed, dried, fused, and weighed the product. The following quantities of bromine were found proportional to 100 parts of silver:—

74·072
74·055
74·066

Mean, reduced to a vacuum standard .. 74·077 ± 0·003

Much more elaborate determinations of this ratio are due to Stas.|| In one experiment a known weight of silver was converted into nitrate, and precipitated in the same vessel by pure hydrobromic acid. The resulting bromide was washed thoroughly, dried, and weighed. In four other estimations the silver was converted into sulphate. Then a known quantity of pure bromine, as nearly as possible the exact amount necessary to precipitate the silver, was transformed into hydrobromic acid. This was added to the dilute solution of the sulphate, and, after precipitation was complete, the minute trace of an excess of silver in the clear supernatant fluid was determined. All weighings were reduced to a vacuum. From these experiments, taking both series as one, we get the following quantities of bromine corresponding to 100 parts of silver:—

74·0830
74·0790
74·0795
74·0805
74·0830

Mean, 74·081 ± 0·0006

Combining this with Marignac's result, 74·077, ± 0·003, we get as a general mean the value 74·0809, ± 0·0006.*

The ratio between silver and potassium bromide was first accurately determined by Marignac.† I give with his weighings, the quantity of KBr proportional to 100 parts of Ag:—

2·131 grms. Ag =	2·351	KBr	110·324
2·559 ,,	2·823	,,	110·316
2·447 ,,	2·700	,,	110·339
3·025 ,,	3·336	,,	110·283
3·946 ,,	4·353	,,	110·314
11·569 ,,	12·763	,,	110·321
20·120 ,,	22·191	,,	110·293

Mean, corrected for weighing in air, 110·343 ± 0·005

Stas,‡ working in essentially the same manner as when he fixed the ratio between potassium chloride and silver, obtained the following results:—

110·361
110·360
110·360
110·342
110·346
110·338
110·360
110·336
110·344
110·332
110·343
110·357
110·334
110·335

Mean, 110·3463 ± 0·0020

Combining this with Marignac's mean result, 110·343 ± 0·005, we get a general mean of 110·3459 ± 0·0019.

The ratios upon which we must depend for the atomic weight of iodine are exactly parallel to those used for the determination of bromine.

To begin with, the percentage of oxygen in potassium iodate has been determined by Millon.|| In three experiments he found:—

22·46
22·49
22·47

Mean, 22·473 ± 0·005

Millon also estimated the oxygen in silver iodate, getting the following percentages:—

17·05
17·03
17·06

Mean, 17·047 ± 0·005

The analysis of silver iodate has also been performed with extreme care by Stas.§ From 76 to 157 grammes were used in each experiment, the weights being reduced to a vacuum standard. As the salt could not be prepared in an absolutely anhydrous condition, the water expelled in each analysis was accurately estimated and the neces-

* See E. Mulder's "Oversigt," p. 117; or Berzelius's *Jahresberichte*, 24, 72.
† *Ann. Chem. Pharm.*, 113, 20.
‡ E. Mulder's "Overzigt," p. 116; Berzelius's *Jahresberichte*, 24, 72.
‖ "Aronstein's Translation," pp. 154-170.

* O. W. Huntington, in his paper upon the atomic weight of cadmium (*Amer. Acad. Proc.*, 1881), gives three analyses and three syntheses of silver bromide. These give a mean value of—
Ag : Br : : 100 : 74·064.
This figure I record here in order that other chemists may not overlook the work of Mr. Huntington, although it came out too late for use in my own calculations.
† E. Mulder's "Overzigt," p. 116; Berzelius's *Jahresberichte*, 24, 72.
‡ "Aronstein's Translation," pp. 334-347.
‖ *Annales de Chim. et de Phys.* [3], 9, 400. 1843.
§ "Aronstein's Translation," pp. 179-200.

sary corrections applied. In two of the experiments the iodate was decomposed by heat, and the oxygen given off was fixed upon a weighed quantity of copper heated to redness. Thus the actual weights, both of the oxygen and the residual iodide were obtained. In a third experiment the iodate was reduced to iodide by a solution of sulphurous acid, and the oxygen was estimated only by difference In the three percentages of oxygen given below the result of this analysis comes last. The figures for oxygen are as follows:—

16·976
16·972
16 9761

Mean, 16·9747± 0·0009

This, combined with Millon's series above cited, gives us a general mean of 16·9771 ± 0·0009.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 1, July 2, 1883.

The Compressibility and the Liquefaction of Gases.—J. Jamin.—This paper cannot be usefully abstracted without the accompanying diagram.

Action of Hydrochloric Acid upon Stannous Sulphide.—A. Ditte.— Dry hydrochloric acid does not attack crystalline tin sulphide at ordinary temperatures, but on applying heat the reaction begins with formation of hydrogen sulphide and stannous chloride. Liquid hydrochloric acid attacks crystalline tin sulphide, even at ordinary temperatures, but the degree of concentration of the acid plays a great part in the phenomenon. If a current of hydrogen sulphide is passed into stannous chloride, the precipitate has not always the same aspect. If hydrochloric acid is brought in contact with an excess of tin sulphide, or if a current of hydrogen sulphide is passed into a solution of stannous chloride, an equilibrium is soon established in the liquids. It was examined whether in concentrated acid solutions there may be formed a hydrochlorate of stannous chloride, the decomposition of which by hydrogen sulphide is not effected in the same manner as that of the chloride, but it is not the case. Hydrochloric acid in the cold attacks hydrated stannous sulphide more rapidly than the anhydrous sulphide. With tin selenide the same phenomena are obtained as with the sulphide. The telluride is attacked by dry hydrochloric acid with the aid of heat, but it is not acted upon by the liquid acid, even in the most concentrated solution.

Fusibility of Salts.—E. Maumené —The author has examined the melting-points of potassium and sodium nitrates mixed in various proportions, and finds that the figures given by calculation differ very widely from those obtained by actual experiment. The latter results are always lower, sometimes by as much as 94°.

A New Method for the Determination of Urea.—L. Hugounenq.—The author filters the urine over animal charcoal, dilutes with water, and heats it to 140° in a sealed tube. The ammonium carbonate formed is then determined by titration, using as indicator the coal-tar colour known as *orange* No. 3. The figures obtained agree very fairly with those given by the hypobromite process. This method may be applied to albumenous urines if the albumen is previously coagulated by heat. It is not available in such as contain glucose or magnesia in notable quantities.

Examination of Corpuscules held in Suspension in Water.—Eug. Marchand.—The author recommends, as a method not new in principle, but which has never yet been put in practice, an optical examination of waters. He places the sample in a clear glass bottle, wrapped in black paper, having two rectangular apertures opposite to each other, one of which serves for the admission of a beam of light, whilst the observer is stationed at the other. When the liquid is optically pure, the light passes without hindrance, but if it is charged, however slightly, with suspended particles, they become visible. M. Marchand calls attention to the existence of certain organisms of about 0·002 metre in diameter, which he considers have hitherto escaped observation.

Justus Liebig's Annalen der Chemie, Band 218, Part 3.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir by Dr. Fr. Stengel, on certain salts of three disulphodialkyl-benzoic acids; a paper by Dr. J. Engelcke, on two disulpho-dialkyl-isæthionic acids, and on attempts to prepare analogous compounds with benzol-sulphonic acid; an account of methyl-sulphonic acid, by Dr. Nithack; and an essay by Prof. Geuther, on the constitution of the double compounds of salts of the sulphonic acids with neutral sulphuric ethers, on the constitution of the sulphates, and on the reason of their dimorphism.

Specific Volumes of the Esters of the Fatty Series.—Emil Elsässer.—The author gives his results in the form of tables. He describes and figures the "dilatometer" with which he performed his experiments, and which was specially constructed by Geissler, of Bonn.

Ketones of the Aromatic Series (Second Treatise).—W. Staedel.—The author here gives an account of tetra-nitro-diphenyl-methan, of tetra-nitro-benzo-phenon, of the reduction of the former of these two compounds, of diamido-benzo-phenon, the reduction of dinitro-benzo-phenon from benzo-phenon, β-diamido-benzhydrol, and of dioxy-benzo-phenon.

Saccharone and Saccharine.—H. Kiliani.—The author describes a number of the salts of saccharone and its behaviour and that of saccharine with hydriodic acid

Communications from the Chemical Laboratory of the University of Lemberg.—These consist of a paper by P. Wispek and R. Zuber, on the action of allyl-chloride upon benzol in presence of aluminium chloride, and a memoir, by Julian Schramm, on the action of bromine upon aromatic hydrocarbons with a saturated lateral chain.

Bulletin de la Société Chimique de Paris. No. 12, June 20, 1883.

"Disinfection" of Alcohol of a Bad Flavour by Electrolysis.—Laurent Naudin.—A bulky paper, requiring the three accompanying illustrations. The inaccurate use of the word "disinfection" is to be regretted.

Penta-chloric Acetone.—Ch. Cloëz.—The author has prepared this compound by two distinct methods: the action of chlorine upon a solution of citric acid at 100°, and by that of dry chlorine upon well-dried acetone under exposure to the sun.

Formation of Certain Sulphides by Pressure, and Considerations Concerning the Allotropic States of Phosphorus and Carbon.—W. Spring.—This paper will be inserted at length.

Researches on the Metallic Derivatives of the Amides. Means of Distinguishing a Monamide from a Diamide.—H. Gal.—Already noticed.

Preparation of Propyl-iodide.—M. Chancel.—The

author introduces 127 grms. iodine, 60 grms. propylic alcohol, and 10 grms. of amorphous phosphorus into a litre flask, which is at once connected with a reflux condenser, well supplied with cold water. When the reaction is over, heat is applied for an hour, and the mixture is then distilled. Water is added to the distillate, and the precipitated ether is decanted. The product is decolourised by agitation with a very dilute alkaline solution, washed with water, decanted again, dried by digestion for twenty-four hours with powdered chloride of calcium, and rectified. The yield is about 90 per cent of the theoretic quantity.

Cosmos Les Mondes.
No. 9, June 30, 1883.

Discovery of Electro-magnetism.—Dr. D. Tommasi.—The author produces a passage from the *Ristretto dei Foglietti Universali*, of August 3, 1802, from which it appears that J. D. Romagnosi had observed the deflection of the magnetic needle occasioned by a galvanic current in the month of May of the same year. The same passage is quoted in Hœfer's "Histoire de la Physique et de la Chimie," p. 298.

MISCELLANEOUS.

Conversazione of the Chemical Societies.—In connection with the Annual Meeting, held in London last week, of the Society of Chemical Industry, Dr. W. H. Perkin, President of the Chemical Society, Sir Frederick Abel, C.B., D.C.L., retiring President of the Society of Chemical Industry, and Dr. Odling, President of the Institute of Chemistry, invited the Members of the three societies to a conversazione on Friday evening at the Galleries of the Institute of Painters in Water Colours, and the Prince's Hall, Piccadilly. The rooms were crowded, and among those present were Admiral Brandreth, Comptroller-General of the Navy, General Sir Collingwood Dickson, President of the Ordnance Committee, General Sir Charles Nugent, General Crawford, General Smyth, Sir Henry Lefroy, F.R.S., Colonel Webbe, C.B., Colonel Donnelly, Colonel Malcolm, R.E., C.B., the President of the Royal Society, Dr. J. H. Gilbert, Professors Adams, Dewar, Guthrie, Hughes, Armstrong, Warington Smyth, Ayrton, Noel Hartley, Huntingdon, Clifton, and Bedson; Mr. A. M. Chance, Mr. Charles Tennant, Mr. E. K. Muspratt, Mr. John Pattinson, Mr. Watson Smith, Mr. C. E. Groves, Mr. James Mactear, Mr. J. M. Thomson, and Mr. W. Crookes.

Hoskins's Hydrocarbon Blowpipe and Furnaces.—For the conduction of metallurgical operations on a small scale, as the testing of smelting charges and such like, or the processes of cupellation and scorification of the assayer, the furnaces and blowpipe apparatus, patented and manufactured by Mr. William Hoskins, of Chicago, in which light mineral oils are used as a source of heat, seem to offer some advantages over the ordinary small gas furnaces in use among assayers, especially in point of portability. The arrangement for producing the flame consists of a reservoir, into which the volatile oil is forced by means of a force-pump, the pressure of the compressed air inside the vessel being sufficient to send the liquid through the tubes of the burner, when it is vapourised by heating the burner, and finally issues from a fine orifice as a highly heated gas, the flame produced being directed into an opening in the side of the furnace containing the crucible or muffle. Gasoline, of 74°, is recommended as being the best fuel, and in ordinary effective operations one gallon is said to last eight hours. The patentee claims for his furnace the merits of performing the ordinary metallurgical operations quicker, better, and with greater accuracy than any other. Starting with the furnace cold, it will melt one-half pound of cast-iron in fifteen minutes or one pound of brass in eleven minutes.

Association of Science and Art Teachers.—President: Professor T. H. Huxley, LL.D., President of the Royal Society.—At a well attended meeting of science and art teachers, held on Saturday, June 2nd, at the Manchester Technical School and Mechanics' Institution, the Association was formally inaugurated by the appointment of an Executive Board, the adoption of Rules, enrolling of Members, and other business. The Association is established to effect the general advancement of the profession of science and art teaching, by securing improvements in the schemes of study and advances in the standard of teaching, together with the establishment of more satisfactory relations between teachers and the Science and Art Department, the City and Guilds of London Institute, and other public authorities, and by endeavouring to secure the adoption of such regulations as are conducive to educational progress. It is not possible to state here all the directions in which useful action may be taken. The successful history of the National Union of Elementary Teachers will, however, suggest the general lines of constitution, organisation, and procedure, applicable to this Association. The Executive will be glad to receive and consider any suggestions for the improvement or advantageous development of the various schemes of instruction in which members are interested, and will take such action as may appear desirable under the circumstances. It will collect such information as may be of service to teachers professionally, and it will endeavour by constant watchfulness to advance the status and material interests of science and art teachers in all directions. The Executive contemplate the formation of affiliated district unions in various parts of the kingdom. As the effectiveneess of the Association will greatly depend upon its strength, which should as far as possible be augmented during the summer months of the present year, the Committee respectfully urge upon teachers to become members at once. The subscription has been fixed at 2s. 6d. per annum. The next General Meeting will be held on Saturday, September 1st, at 7.30 p.m. All communications should be addressed to the Hon. Sec., W. E. Crowther, Technical School and Mechanics' Institution, Manchester.

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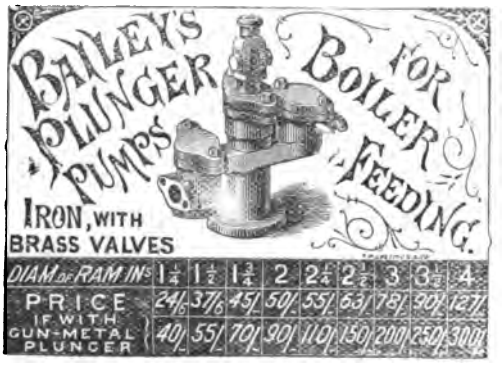
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1235.

A NOTE ON A PECULIAR EXCRETORY PRODUCT, FOUND IN THE "LIVER" OF *SEPIA OFFICINALIS*.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts; Medallist in Chemistry and Botany, &c.

WHEN dissecting a fresh *Sepia officinalis* (the cuttle-fish), a short time ago I noticed a number of small roundish bodies of a dark colour in the substance of the so-called "liver" of this animal. I have noticed them before in the "liver" of the Sepia, but they are not of constant occurrence; perhaps they may be abnormal. I have made a chemical examination of them as far as possible with such small quantities for experimentation. These dark coloured bodies (about 1-12th of an inch in diameter) were only found in the anterior part of the organ. Under the microscope they appear to be aggregations of crystal-like bodies; the forms recognised were octohedra, rhombohedra, and cubes. On detaching several of these roundish bodies from the "liver" and heating them on a platinum capsule, they were first converted into carbonaceous masses, and on ignition left a microscopic amount of ash. This experiment shows that these crystalline bodies are of an organic nature and are not true crystals of a mineral composition. The minute quantity of ash left on ignition when examined spectroscopically gave the characteristic green lines of copper. On separating these roundish bodies from the "liver" of the Sepia, teasing them out with needles, mounting them in weak glycerin, and then treating with certain reagents under the microscope, the following reactions were observed:—

Microscopic Reactions.

(α). On running in between the slide and the cover-slip a solution of iodine in potassium iodide; these pseudo-crystals (if I may so term them) were stained brown.

(β). On running in dilute potash solution the pseudo-crystals disappeared.

(γ). When treated with Millon's reagent (mercuric nitrate) and the slide heated over a spirit-lamp, a red colour was produced.

(δ). When treated with concentrated nitric acid a yellow colouration was observed due to the formation most probably of the xanthoproteic acid of Mulder, for on running in the dilute potash this yellow colour turned red.

Chemical Reactions.

(1). When several of these roundish bodies were boiled in a small test-tube with pure hydrochloric acid a blue colour was formed, which ultimately changed to violet, and then to brown.

(2). On heating a quantity of these bodies with solid caustic potash in a test-tube, ammonia was evolved.

(3). On dissolving these bodies in a soluion of potash, and then boiling with lead hydrate dissolved in dilute potash, lead sulphide was formed. From these experiments and observations I come to the conclusion that these pseudo-crystals have the composition of *albumin*, inasmuch as they contain nitrogen and sulphur proved by the last two experiments; and the microscopic reactions all go to confirm that these excretory products are of an albumenoid character. I tried to make a combustion analysis of these bodies, but had too small a quantity to operate upon for a successful issue. I submit that these albuminous crystals are true excretory products of this so-called "liver" of *Sepia officinalis*. From the chemical composition of these bodies found, I think these investigations give further evidence in favour of the supposition that this so-called "liver" of the Cephalopod is not a true liver like that of the higher animals, but is "pancreatic in function," for we know that in the higher animals albumenoids are decomposed in the liver, while the fluid of the pancreas is one of the few seeretions which contains albumin in a soluble form. Long ago Tiedemann and Gmelin in some cases found the proportion of albumin to amount to 4 per cent of the entire fluid of the pancreas. Therefore, if albuminous crystals are at times to be excreted by, and found in, the substance of this so-called "liver," I think the fluid contained in this organ must contain albumin as a constituent, and is in fact a true pancreas, or digestive organ. These albuminous crystals are most likely similar to the crystalloids (which are of a protein nature) found in certain cells of plants.

As I stated at the beginning of the paper these pseudo-crystals are not of constant occurrence in this organ; if they are abnormal or the products of disease, all I can say is they appear to be deposited from the secretion of this organ, showing that it contains albumin, and from this circumstance I think the conclusion to be drawn is that this organ is more of a pancreas than a liver.

This albumin (or "sanguigenous body" as Liebig liked to call it) found in pseudo-crystalline aggregations in the anterior part of the Sepia's "liver" yielded, as I stated before, on ignition a microscopic ash, which, when treated with pure hydrochloric acid and examined with the spectroscope, gave most prominently the copper spectrum. The copper must have been derived from the blood of the animal, for it is well-known that the blood of *Sepia officinalis* contains copper.

The dark colour of these crystalloid aggregations which were alluded to at the commencement of the paper was, under the microscope, seen to be a very thin and superficial covering, and may be some colouring matter—probably the same chlorophyll pigment which Dr. C. A. MacMunn described in a paper which was read before the Royal Society on the 5th of April last; he having found it in the so-called "liver," &c., of the Mollusca, Arthropoda, Echinodermata, and in the invertebrata generally.

LAVOISIER AND MODERN SCIENCE.

By G. F. RODWELL.

THIS memoir, which we find in the *Revue Scientifique* for May 26, 1883 (3e Série, 3e Année, No. 21), is of such grave importance for the history of chemical science that it fitly requires careful notice. It is nothing less than an able and successful vindication of the scientific merit of Lavoisier, and a refutation of certain charges which have been commonly brought against him. He has been commonly and very emphatically accused of appropriating the discoveries of his contemporaries. Thus Dr. Thomson, in his well known "History of Chemistry," states that Lavoisier claimed the discovery of oxygen gas for himself, but that his claim merits no notice, as Priestley had shown him the process in 1774, "long before the date assigned by Lavoisier to his pretended discovery." It is said that, though he had been informed by Cavendish of the composition of water, he nevertheless sought to appropriate this discovery. On this subject James Watt, who also puts in a claim to have first observed the compound nature of water, wrote in 1784:—"Immediately after the appearance of my memoir on this subject Dr. Blagden explained my theory to M. Lavoisier, at Paris, and shortly after M. Lavoisier discovered it himself, and presented a memoir on the subject to the Academy of Sciences. Since then Mr. Cavendish presented to the Royal Society a memoir on the same subject without making mention of me. The one is a French financier,

whilst the other belongs to the illustrious house of Cavendish. The great sometimes commit paltry actions." It will not be deemed out of place if we pronounce it utterly inconceivable that a man so regardless of the honour accruing from his own discoveries—and who often did not think it worth while to make them known—should appropriate those of others.

Brande seems to apologise for the sins of Lavoisier as due to haste and inadvertence, and Liebig omits his name among the founders of the new era in chemistry.

Having thus summarised the principal charges against Lavoisier, we turn to Mr. Rodwell's reply. He points out the erroneous nature of the assumption that Lavoisier first referred to the existence of oxygen and the composition of air and of water in his "Traité de Chemie," published in 1789. Hence many authors have supposed that his experiments on this subject had then been but recently made. But he mentions oxygen and the nature of the air twelve years earlier, in a paper read before the Academy May 3rd, 1777, and bearing the title "On the Respiration of Animals, and on the Changes which Air Undergoes in Passing through their Lungs." It further appears that he had obtained oxygen, by means of the red precipitate of mercury, more than two-and-a-half years before the date of the paper. This brings us to some time in the year 1774! Now Priestley did not obtain oxygen until August in the same year, so that the difference in date is very trifling.

Dr Thomson, in his "History of Chemistry," criticising Lavoisier's "Opuscules Physiques et Chimiques," published, it must be remembered, early in 1774, and bearing date December 3rd, 1773, says:—"Nothing in these researches indicates that Lavoisier suspected air to be a mixture of two distinct fluids, one of which only intervenes in combustion and calcination. Yet Priestley had already deduced this fact from his own experiments, and Priestley had discovered the existence and the characteristic properties of oxygen gas." But in the "Opuscules" Lavoisier shows distinctly that air is composed of two fluids, one of which is absorbed during calcinations. This announcement was not merely prior to Scheele's deduction of the composition of air from his own experiments, and even eight months before Priestley obtained oxygen from the red oxide of mercury. "Thus," says Mr. Rodwell, "the accusations of Dr. Thomson fall and disappear one after the other."

It has been often said that Lavoisier had the habit of using the ideas of others without acknowledgment. Mr. Rodwell, on examining Lavoisier's original memoirs, finds that he was constantly and scrupulously careful in his referring to the works of other authors. Thus in 1776 Lavoisier wrote:—"I will begin by informing the public that a part of the experiments contained in this memoir do not in strictness belong to me; perhaps, correctly speaking, there is none of them of which M. Priestley might not claim the original idea, but as the same facts have led us to conclusions diametrically opposite, I hope that if anyone reproaches me for having borrowed proofs from the works of this celebrated physicist my claim to the conclusions will not be contested."

In the same year, in a treatise on muriatic acid, ammonia, and sulphurous acid, he writes—"The experiments of which I have just given an account belong almost all to Dr. Priestley; I have merely the merit of having repeated them with care, and above all of having arranged them in an order suitable for showing their consequences."

Again, in 1777, in a memoir on "Respiration," Lavoisier writes that Priestley, "by means of highly ingenious, very delicate, and novel experiments," has endeavoured to prove that respiration phlogisticates the air like calcination.

The passages just quoted are certainly not couched in the language of a systematic plagiarist,—an appropriator of the merits of others.

But we must pass on to the main accusation. What foundation have the detractors of Lavoisier for maintaining that he laid any dishonest claim to to the discovery of oxygen? He writes in his "Traité de Chemie:—This air which M. Priestley, M. Scheele, and myself have discovered almost simultaneously."

Further, in 1782, in a work entitled "Sur un Moyen d'Augmenter considérablement l'Act on du feu et de la Chaleur dans les Opérations Chimiques," Lavoisier, speaking of oxygen, says:—"This gas, which M. Priestley discovered about the same time as I myself, and indeed, I believe, before me." Here, then, Lavoisier, so far from claiming anything not his own, explicitly admits Priestley's priority in all that was justly his due. For we must bear in mind that for some months Priestley was completely ignorant of the nature of the gas which he had discovered. In October, 1774, and even later, he believed that it was ordinary air containing "nitrous corpuscules." Even to his death he remained a determined partisan of the phlogiston theory. Consequently he never rightly understood the part played by oxygen, whether in the chemistry of nature or of art.

Having arrived at this point, Mr. Rodwell raises the question, what is the true sense of the words "discovery" and "discoverer"? Is the discoverer the man who first sees or produces a new fact, a novel phenomenon, or rather the man who first recognises its nature and its relations with other facts? Mr. Rodwell reminds us that nearly 300 years before Priestley, Eck, of Sulzbach, noted the increase of weight of mercury when submitted to oxidation—or, as it was then called, to calcination—and on submitting this "calx" to a higher temperature he obtained "a spirit,"—evidently oxygen gas. Hence Priestley did not find the ground entirely unoccupied.

Our author calls also to mind that Robert Hooke, and still more Robert Mayow, came much closer upon the theories of Lavoisier than ever did Priestley. If Hooke's twelve propositions on combustion had not been buried in a book on microscopic discoveries little likely to be studied by chemists, and if Mayow had not died at the early age of 34, it is not improbable that the Phlogistian system might never have originated, and that Lavoisier, starting on a higher plane, might have been able to devote his splendid genius to yet more important tasks than those which fell to his lot. Be this as it may, we cannot but rejoice to find the reputation of this illustrious chemist effectually cleared from the charges of plagiarism which have been brought against him. Mr. Rodwell observes, in conclusion, that it would be impossible to compare two minds more fundamentally opposite than Lavoisier and Priestley. "The latter experimented at random and made his discoveries, so to speak, by accident. Lavoisier worked methodically, and his results often confirmed his theories. Priestley was an obstinate upholder of phlogiston, and refused to abandon it long after its falsehood had been recognised by the *savants* of Europe. Lavoisier, by the most beautiful series of deductions, overturned this theory, which his predecessors had so long accepted, and on its ruins he erected a monument henceforth imperishable."

Researches on the Destruction and Utilisation of the Bodies of Animals Dead of Contagious Maladies, and especially of Splenic Fever.—Aimé Girard.—Sheep dead of "charbon," entire and still covered with their fleeces, were placed in a wooden vat lined with lead, and filled to one-third with sulphuric acid at sp. gr. 1·625°. In about 24 to 48 hours, without the application of heat, the carcases disappeared entirely, the specific gravity of the acid being reduced to 1·39°. The acid is capable of thus dissolving more than two-thirds of its weight of animal matter. The black, acid, and nitrogenous syrup thus formed has been examined by one of the most skilful assistants of M. Pasteur (M. Roux), who has proved, both by inoculation and by culture, that no germ of the disease survives. The acid contains 0·8 per cent of nitrogen and 0·5 of soluble phosphoric acid, and may be advantageously used in the manufacture of superphosphate.—*Comp. Rend.*

ON SAMARIUM.

By P. T. CLÈVE.

In 1878 M. Delafontaine found that the didymium of samarskite is accompanied by a new element with a peculiar absorption-spectrum and a higher atomic weight. He gave to this element the name of decipium. The following year M. Lecoq de Boisbaudran isolated in very small quantity, from the fractions of the earths of samarskite rich in didymium, an oxide, the absorption-spectrum of which he minutely described, the metallic radicle of which has been named *samarium*.

In 1880 M. Delafontaine published his researches on decipium, and shortly afterwards M. Marignac published his examination of the earths of samarskite which accompany terbium. He described under the symbol $Y\beta$ an oxide, the absorption-spectrum of which agrees with the spectrum of samarium, the maximum atomic weight of the metal being 99·6 or 149·4 (the oxide being RO or R_2O_3). The salts are characterised by their yellow colour. Decipium, according to M. Delafontaine, yields colourless salts, and the atomic weight of the metal is 144 (RO) or 171 (R_2O_3), which differs considerably from the figures of M. Marignac.

Subsequently M. Delafontaine found that his decipia of 1878 was a mixture of an oxide with the spectrum of samarium, for which he adopts the name samarium, and another oxide without absorption-spectrum, for which he retains the name of decipium. The metal of the former oxide has the atomic weight 101 (SmO, or 151·5 Sm_2O_3), and that of the latter 114 (DpO, or 171 Dp_2O_3). From these two oxides the author has obtained samarium oxide in a state of purity, that is to say, free from didymium and of a constant molecular weight. The raw material was an oxide of didymium, obtained from the orthite of Arendal, from cerite, gadolinite, and keilhauite. He separated the samarium oxide from the didymium by repeated precipitations with dilute ammonia, operations which required the continuous work of five months.

The oxide of samarium thus obtained was still not pure. It contained terbia and an oxide of a higher atomic weight, probably the Yα of M. Marignac. It was necessary to submit it to repeated precipitations with potassium sulphate, until the oxide remaining in solution had the same molecular weight as the precipitated.

Taking for the oxide the formula Sm_2O_3, which agrees perfectly with its chemical characters, six experiments with different fractions gave atomic weights ranging from 149·940 to 150·120. The mean of these determinations is 150·021.

Samarium oxide is white with a scarcely perceptible yellowish tint. It dissolves readily in acids, and gives salts of a topaz colour. The hydrate is white and gelatinous: it is a stronger base than yttria and terbia, but less powerful than didymium oxide. The author has prepared and analysed the chloride $SmCl_3+6H_2O$ in large deliquescent crystals; the chloro-platinate,—

$$SmCl_3+PtCl_4+10\tfrac{1}{2}H_2O,$$

forming long orange prisms; the platino-cyanide—

$$2Sm(CN)_3+3Pt(CN)_2+18H_2O,$$

yellow prisms with a bluish reflection; the nitrate, $Sm3NO_3+6H_2O$, pale yellow prisms; the acetate, $Sm3C_2H_3O_2+4H_2O$, in short prisms; the sulphate, $Sm_23SO_4+8H_2O$, is much less soluble than the corresponding salt of didymium; the seleniate, $Sm_3SeO_4+8H_2O$, resembles the sulphate, but is readily soluble; the double potassium sulphate is a white powder, sparingly soluble, $2Sm_23SO_4+9K_2SO_4+3H_2O$; the double ammoniacal sulphate, $Sm_23SO_4+(NH_4)_2SO_4+8H_2O$, forms small distinct crystals. The selenite, $Sm_2O_3,O_3,4SeO_2+5H_2O$, was obtained by the action of selenious acid upon the acetate. It is a precipitate consisting of microscopic needles. The oxalate, $Sm_23C_2O_4=10H_2O$, is a crystalline powder. In its chemical characters samarium approaches more to didymium and less to the yttria metals. The composition of its salts is the same as that of the salts of didymium. The formulæ of the chloro-platinate, of the ammoniacal sulphate, and of the selenite place the formula Sm_2O_3 beyond all doubt.—*Comptes Rendus*.

A SIMPLE METHOD OF CORRECTING THE WEIGHT OF A BODY FOR THE BUOYANCY OF THE ATMOSPHERE WHEN THE VOLUME IS UNKNOWN.

By JOSIAH PARSONS COOKE.

It is a familiar fact that in the usual method of accurate weighing the buoyancy of the atmosphere produces a sensible effect whenever the volume of the load differs materially from that of the equipoise. But, as in all ordinary processes of chemical analysis the analyst deals solely with relative weights, the presence of a perfectly dry atmosphere does not influence his results, unless the conditions of temperature and pressure have changed between the successive weighings: and even then the effect is insignificant in most cases. Still when the volume of the vessel weighed differs from that of the weights by a little as 25 cubic centimetres—for example in weighing the absorption tubes used in "organic analysis"—the error caused by variations in the density of the atmosphere may be sufficient to seriously impair the accuracy of the result.

In weighing large vessels—as in determining the density of a gas—the effect of any variation of buoyancy is eliminated by the well known effects of calculating the results. But the formulæ usually given for that purpose involve as known quantities the volume of the vessel, the volume of the weights, the density of the air under the standard conditions, as well as the temperature and pressure at the moment of the several observations; and since the calculations are somewhat complex, and the required data not always readily obtained, the formulæ are seldom applied unless the volume of the load is quite large. Moreover in these formulæ the effect of each factor can not readily be traced, and most analysts are probably not aware of the extent to which their weighings may be influenced by changes in the density of the air due to variations of temperature and pressure. In seeking to fix the weight of certain absorption-tubes (in connection with my work on the revision of the atomic weights) I have been led to a method of correcting the weights of such tubes for variations of buoyancy: which, while it does not involve the determination of any data except the temperature and tension of the air in the balance-case, and is as simple in its application as the calibration of a flask, also gives a clear conception of the effect of each variable on the weight.

It is assumed that the air of the balance-case is dry; and with one of Becker's balances I have not been able to trace any effect on the weight of a glass vessel from variations of hygrometric condition when two open dishes of sulphuric acid (three inches in diameter) were kept in the case, which has a volume of about 37 cubic decimetres. Under such conditions the only causes which sensibly modify the weight of a small glass vessel (like a closed potash bulb-tube) are the variations of temperature and pressure. The relative effect of these two variables will appear from the following considerations, which suggested the method I am to describe. If we assume thirty inches as the standard of barometric pressure it is obvious that the variation of each tenth of an inch from this standard will determine a change of 1 300th in the resultant effect of the buoyancy of the air on the load and its equipoise. Again, if we assume 27° C. as our standard of temperature—that is 300° on the so-called "absolute scale"—then according to the law of Charles the variation of each

degree from this point will also cause a change of 1-300th in the same resultant. In other words, counting from these standards, a variation of one degree in the centigrade thermometer indicates the same effect on the density of the atmosphere—and therefore on its buoyancy—as the change of one-tenth of an inch in the mercurial barometer. In our climate the barometer changes slowly, and its fluctuations do not ordinarily exceed one inch. On the other hand the balances in our chemical laboratories are liable to rapid variations of temperature which often exceed twenty degrees, the equivalent of two inches. Hence of the two variables the temperature is by far the more important.

If we select the two standards of temperature and tension here assumed, we can easily correct for temperature by simly adding to the observed height of the barometer (in tenths of an inch) the difference between 27° C. and the temperature observed. Of course the correction becomes negative if the temperature exceeds 27° C. Having thus eliminated the effect of temperature we can (after taking a few weighings under as great a variation of temperature and pressure as we can command) easily find the difference in weight which corresponds to a variation of one-tenth of an inch in the barometer, and we thus obtain a constant for the vessel (or other object weighed) by means of which we can rapidly reduce the weights to the standard of thirty inches barometric pressure, having previously reduced them to the standard of 27° C. for temperature. The weights, having now been corrected for buoyancy, can be compared, and although the standards may be as unusual in their association as is one of them in its value, they are as legitimate as any others and will be found in practice more convenient.

To apply this method we simply leave the load equipoised on the balance, shifting the rider with the varying weight, and noting the corresponding temperatures and pressures, until a sufficient difference has been observed; and a difference corresponding to 20° C., or two inches of mercury, is adequate in most cases. The process corresponds to calibrating a flask, and the constant, once obtained, can be afterwards used for the same vessel, unless the weight of its contents is materially altered. The following examples will show the application of the method.

In each case the load was a closed absorption-tube of peculiarly irregular construction, but not much larger in volume than those generally used in organic analysis. We give in the accompanying tables—first, the date; secondly, the observed weight; thirdly, the temperature of the balance-case; and, fourthly, the height of the barometer at the time of weighing. These are the observed data. In the fifth column we give the reduced heights of the barometer for 27° C., and these values are obtained by simply subtracting the observed temperatures from 27°, and adding the remainders to the observed barometric heights. Below the tables we print in each case the largest weight observed over the least weight observed, nnd on the same lines the corresponding reduced barometric heights. Dividing, now, the difference of weight in milligrms. by the difference of height in tenths of an inch we obtain the value last given, which we then called the "constant." With this constant we can readily reduce all the weights to the common standard of thirty inches, and this we do by multiplying the difference between 300 and the reduced barometric heights by this constant, and adding or subtracting the product, as the case may be, to or from the observed weights (see Table, next column).

The balance here used is only sensitive under such a load to the tenth of a milligrm., and hence the constancy of the results obtained is very striking. There can be no question that the mean of several weighings is accurate to the full limit of the sensibility of the instrument used. Moreover during the course of the observations it was also evident that the slight variations observed (only 3-tenths of a milligrm. between the extreme limits) were owing to a want of exactness in the measure of the temperature of the balance-case. We used a common thermometer reading only to whole centigrade degrees; although, as afterward appeared, a difference of only 3-tenths of a degree caused a difference of 1-tenth of a miligrm. in the weight, and a difference of a whole degree corresponded to the extreme difference between the observations. In the second series (made with the same tube but differently mounted) we used a standard thermometer (Geisler's make) reading to tenths of a degree, and the results are all that could be expected with the instruments employed. The observations were made, nevertheless, under the most unfavourable conditions, during exceedingly hot weather when the temperature was rapidly changing; and it was evident that the insignificant differences remaining arose from the circumstance that the thermometer was not nearly so sensitive as the air in the balance-case, following the change of temperature of the air after a considerable interval of time. It was curious to notice the slight increase of weight caused by the radiation of the body while weighing, followed only after some time by a rise of the very sensitive thermometer employed, and this effect was obtained in weighing a vessel which displaced only about 75 cubic centimetres of air.

First Series.

No.	1883.	Weight.	C.°	H.	H reduced	Result.
1	May 1	87·5304	17°	304·0	314·0	87·5346
2	May 2	87·5303	17°	304·2	314·2	87·5346
3	May 2	87·5314	19·5	303·2	310·7	87·5346
4	May 3	87·5322	20°	301·0	308·0	87·5346
5	May 4	87·53205	20·5	301·9	308·4	87·5346
6	May 4	87·5320	21°	302·5	308·5	87·5346
7	May 6	87·5316	18°	300·8	309·8	87·5345
8	May 7	87·5320	19°	300·0	308·0	87·5344
9	May 8	87·5328	19·5	298·9	306·4	87·5347
10	May 9	87·53245	22°	302·2	307·2	87·5346
11	May 11	87·5333	22°	299·5	304·5	87·5346
12	May 11	87·5333	19·5	296·2	303·7	87·5344
13	May 19	87·5317	21°	303·5	309·5	87·5346
14	May 21	87·5345	23°	296·2	300·2	87·5346
15	May 22	87·5336	22°	298·0	303·0	87·5345
	Greatest weight		87·5345		Barometer	300·2
	Smallest weight		87·5303		,,	314·2
	Differences,		42			14·0

Constant = 4·2 m.g. ÷ 14·0 = 0·3 m.g.

Second Series.

No.	1883.	Weight.	C.°	H.	H reduced.	Result.
1	May 29	87·3447	23·5	297·6	301·1	87·3451
2	May 30	87·3432	23·2	302·0	305·8	87·3451
3	May 30	87·3437	24·5	301·8	304·3	87·3451
4	May 31	87·3444	23·8	298·8	302·0	87·3450
5	June 1	87·3429	22·8	302·4	306·6	87·3450
6	June 1	87·3432	23·75	302·4	305·65	87·3450
7	June 2	87·3419	22·6	305·2	309·6	87·3451
8	June 3	87·3420	21·95	304·5	309·55	87·3450
9	June 3	87·3427	23·15	303·8	307·6	87·3451
10	June 4	87·3441	25·0	301·1	303·1	87·3451
11	June 5	87·3443	26·0	301·4	302·4	87·3451
12	June 5	87·3446	26·3	300·6	301·3	87·3450
13	June 6	87·34435	25·55	300·75	302·2	87·3451
14	June 7	87·3452	26·7	299·0	299·3	87·3450
15	June 8	87·3464	29·4	297·9	295·5	87·3450
	Greatest weight		87·3464		Barometer,	295·5
	Smallest weight		87·3419		,,	309·6
	Differences,		45			14·1

Constant = 4·5 m.g. ÷ 14·1 = 0·319 m.g.*

* In combining only the extreme weights we must obviously take care that neither of them is seriously affected by any accidental errors; and a more certain value of the constant would be obtained by combining all the observations, after well known methods. This complication, however, is seldom necessary, as such errors would render the final results irregular, and lead to a re-discussion of the observations.

The limits in the accuracy of the method here described are obvious; but it will be noticed that the accuracy of the method is exactly proportional to the requirement. The greater the volume of the load, and hence the greater the effect of buoyancy, the more accurately can the "constant" be found, by which the correction, required in any case, may be calculated; and, as the above examples abundantly prove, the accuracy is sufficient for the purpose in view. When the volume of the load is large it becomes necessary to measure the temperature and pressure with great precision, and to protect the balance from radiation and from all causes of rapid change of temperature. It was a great satisfaction to the writer to find that by so simple means the relative weight of glass vessels of considerable size may be determined with accuracy to the tenth of a milligrm., an accuracy which is fully equal to that of the most refined processes of chemical analysis, and which enables us to attain a great degree of precision in many processes which otherwise would not be susceptible of such refinement.

From the data given, and from the known normal density of the atmosphere, it can be easily calculated that in the first series of weighings the volume of the tube and mountings exceeded that of the weights by about 75 cubic centimetres. With this difference of volume we have a variation of 3-tenths of a milligrm. in weight for a difference of 1-10th of an inch of mercury in tension, or one centigrade degree in temperature. Hence with a difference in volume of one hundred cubic centimetres we should have a variation of weight amounting to about four milligrms. for every difference of one inch in the barometer, or of ten degrees in the centigrade thermometer; and these data wil furnish the basis for a rude estimate of the effect in any given case. If the difference of volume amounts to 2500 cubic centimetres, then a difference of 1-1000th of an inch in the barometer, or of 1-100th of a degree in the therometer, would cause a variation of 1-10th of a milligrm. in the weight. So also a variation in the intensity of gravity amounting to only 1-30,000th of the whole amount would produce a similar effect, and a sensible variation would follow any marked change in the purity of the air. Hence the balance might be used to detect exceedingly minute changes in any one of these variables, provided the others could be exactly controlled; and, although with our better methods, these applications of the balance may be of no practical value; yet, the considerations here adduced will serve to show how sensitive the instrument is to the slightest changes in the density of the atmosphere when loaded with vessels of large volume. The best method of controlling the weight in such cases is that adopted by Regnault in his classical work on the density of the more permanent gases. This consists in balancing the vessel whose contents are to be weighed with a second vessel of equal volume, the two hanging side by side in a case lined with thick felt. The balance is set over the case and the vessels suspended from the pans by means of platinum wires, which hang freely through holes in the base of the instrument.—*American Journal of Science.*

ESTIMATION OF CHLORINE, SULPHURIC ACID, AND CHROMIUM IN THE PRESENCE OF ORGANIC MATTER.*

By CHARLES T. POMEROY.

The determination of chlorine, sulphuric acid, and chromium in the presence of organic matter, as in the case of the analysis of many dye-stuffs, is a matter of considerable difficulty. It is necessary to get rid of the organic matter by ignition with alkali carbonate and nitrate, else the determination of the chromium will not be reliable. During the oxidation of the organic matter a portion of the nitrate is reduced to nitrite, and on acidifying the solution, preparatory to the precipitation of the chlorine, the nitrous acid reduces some of the chromate to green chromous chloride, in the presence of which silver nitrate fails to precipitate the whole of the chlorine.* If an attempt is made to precipitate the sulphuric acid in this solution, it will be found that the barium sulphate retains chromic oxide.†

It becomes necessary, therefore, after destruction of the organic matter, to entirely convert the chrominm into a chromic salt before the chlorine and sulphuric acid can be determined with accuracy. The reduction with alcohol is not practical in this case, since chlorhydric acid must be added. Neither can the reduction by means of hydrogen sulphide be taken advantage of; for, on standing in a warm place, there is danger, not only of losing chlorhydric acid, but also of oxidising a portion of the hydrogen sulphide to sulphuric acid. The reduction with sulphurous acid is out of the question, for similar reasons.

The following method I have found to give satisfaction. To the solution of chromate containing sulphates, chlorides, chromates, and salts of chromium, obtained by extraction of the mass which has been fused with alkali carbonate and nitrate, and filtration from the residue, which contains the iron, lime and magnesia, a solution of potassium, sodium, or ammonium nitrate is added and then nitric acid in excess. After standing in the cold for about twelve hours, ammonium hydroxide is added and the whole boiled, the precipitate of chromic hydroxide filtered off, washed with hot water (best with the aid of a filter-pump) and estimated as usual. In the filtrate from the chromic hydroxide, the sulphuric acid is estimated as barium sulphate, by precipitation with barium nitrate and nitric acid. It is occasionally necessary to purify the barium sulphate by fusion with sodium carbonate and re-precipitation.

In the filtrate from the barium sulphate the chlorine is precipitated by silver nitrate as usual.

In the presence of an alkali nitrite and nitric acid, the reduction of the chromic acid takes place immediately on boiling the solution. Advantage may be taken of this when it is required to determine the sulphuric acid alone, since in this case there is no danger of loss on boiling.

The chromates are reduced to chromic salts by the nitrite, which passes into nitrate, while the chromous salts are oxidised by the nitric acid into the chromic state.

The following analyses were made to test the accuracy of the method:—

10 c.c. of a dilute chlorhydric acid gave—

	I.	II.	Mean.
AgCl ..	1·0794	1·0790	1·0792

Dissolved 2·4 grms. of $K_2Cr_2O_7$ in 200 c.c. water:—

I.	II.	III.‡	Mean.	Calc.
25 c.c. $K_2Cr_2O_7$ sol.—				
0·3000 grm.	0·3000 grm.	0·3000 grm.	0·3000 grm.	—
5 c.c. HCl	5 c.c. HCl	5 c.c. HCl	5 c.c. HCl	—
Cr_2O_3 found—				
0·1561	0·1559	0·1550	0·15566	0·15543
AgCl found—				
0·5397	0·5399	0·5391	0·53956	0·5396

In these analyses the acid was neutralised with ammonium hydroxide, sodium nitrite and then nitric acid added. It was not thought necessary to check the sulphuric acid determinations, as there was nothing in the method to interfere with this determination. In practice, the duplicate results agreed excellently.

In the analysis of commercial chrome-yellow by this

* This research was begun in the Rutgers College Laboratory and finished in Mr. Pomeroy's private laboratory in Newark.—P. T. Austen.

* Peligot, "Fres. Quant. Anal.," Last Am. Ed., 432.
† "Fres. Quant. Anal.," 1876, 354.
‡ Nos. 1 and 2 were precipitated in glass, No. 3 in porcelain.

method, the lead, even when present as sulphate and chloride, passes entirely into solution upon adding sodium nitrite and nitric acid in sufficient quantities and boiling.

Sodium nitrite suitable for this purpose can be prepared by simply heating to redness for some time in a closed iron vessel, sodium nitrate, free from sulphates, chlorides, and silica, until nearly one molecule of oxygen has been driven off, and then dissolving the mass in water and filtering off the oxide of iron and other insoluble impurities.

The crude sodium nitrate can be purified by dissolving the commercial article in water, filtering, precipitating sulphuric acid, if it contains any, with barium nitrate, filtering, precipitating the barium with sodium carbonate, filtering, adding an excess of nitric acid, and heating with small additions of nitric acid, until free from chlorine, nearly neutralising with sodium carbonate and then crystallising.

The method of preparing sodium nitrite mentioned by Fresenius* has not proved satisfactory in my hands as the one just given. In almost all cases the bottom of the iron vessel melts out. In one case, the iron bottom, which was a quarter of an inch thick, melted out within fifteen minutes at a hardly visible red heat. The product thus obtained is also very liable to contain but little nitrite, being almost all transformed into the hydroxide, and hence has but little reducing effect on the chromates. It is perhaps possible that the oxide of lead acts as a carrier of oxygen to the iron, taking up oxygen from the nitrate and giving it up to the iron. In this way a small quantity of lead oxide might effect the destruction of a large amount of iron.—*American Chemical Journal.*

A RECALCULATION OF THE ATOMIC WEIGHTS.†

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

Continued from p. 34).

The ratio between silver and potassium iodide seems to have been determined only by Marignac,‡ and without remarkable accuracy. In five experiments 100 parts of silver were found equivalent to potassium iodide as follows:—

1·616 grm. Ag	= 2·483 Ki	Ratio,	153·651
2·503 ,,	3·846 ,,	,,	153·665
3·427 ,,	5 268 ,,	,,	152·720
2·141 ,,	3·290 ,,	,,	153·667
10·821 ,,	16·642 ,,	,,	153·794

Mean, 153·6994 ± 0·0178

The synthesis of silver iodide has been effected by both Marignac and Stas. Marignac, in the paper above cited, gives these weighings. In the last column I add the ratio between iodine and 100 parts of silver:—

15·000 grm. Ag gave	32·625 AgI.	117·500
14·790 ,,	32 170 ,,	117·512
18·545 ,,	40 339 ,,	117·519

Mean, corrected for weighing in air, 117·5335±0·0036

Stas‖ in his experiments worked after two methods, which gave, however, results concordant with each other and with those of Marignac.

In the first series of experiments Stas converted a known weight of silver into nitrate, and then precipitated with pure hydriodic acid. The iodide thus thrown down was washed, dried, and weighed without transfer. By this method 100 parts of silver were found to require of iodine:—

117·529
117·536

Mean, 117·5325, ± 0·0024

In the second series a complete synthesis of silver iodide from known weights of iodine and metal was performed. The iodine was dissolved in a solution of ammonium sulphite, and thus converted into ammonium iodide. The silver was transformed into sulphate and the two solutions mixed. When the precipitate of silver iodide was completely deposited the supernatant liquid was titrated for the trifling excess of iodine which it always contains. As the two elements were weighed out in the ratio of 127 to 108, while the atomic weight of iodine is probably a little under 127, this excess is easily explained. From these experiments two sets of values were deduced; one from the weights of silver and iodine actually employed, the other from the quantity of iodide of silver collected. From the first set we have of iodine for 100 parts of silver:—

117·5390
117·5380
117·5318
117·5430
117·5420
117·5300

Mean, 117·5373 ± 0·0015

From the weight of silver iodide actually collected we get as follows. For experiment number three in the above column there is no equivalent here:—

117·529
117·531
117·539
117·538
117·530

Mean, 117·5334 ± 0·0014

Now, combining these several sets of results, we have the following general mean:—

Marignac	117·5335 ±	0·0036
Stas, 1st series ..	117·5325	0·0024
,, 2nd ,, ..	117·5373	0·0015
,, 3rd ,, ..	117·5334	0·0014
General mean ..	117·5345 ±	0·0009

One other comparatively unimportant iodine ratio remains for us to notice. Silver iodide, heated in a stream of chlorine, becomes converted into chloride; and the ratio between these two salts has been thus determined by Berzelius and by Dumas.

From Berzelius* we have the following data:—In the third column I give the ratio between AgI and 100 parts of AgCl.

5·000 grm. AgI gave	3·062 AgCl	163·292
12·212 ,,	7·4755 ,,	163·360

Mean, 163·326 ± 0·023

* "Qual. Anal.," Last Am. Ed., 71.
† Smithsonian Miscellaneous Collections. "The Constants of Nature."
‡ "Berzelius's Lehrbuch," 5th edition, vol. iii., pp. 1196.
‖ 'Aronstein's Translation," pp. 136, 152.

* *Ann. d. Chim. et de Phys.* [2], 40, 30. 1829.

Dumas'* results were as follows:—

3·520 grm. AgI	gave	2·149 AgCl.	163·793
7·011 "		4·281 "	163·770

Mean, 163·782 ± 0·008

General mean from the combination of both series, 163·733 ± 0·0076.

We now come to the ratios connecting sulphur with silver and chlorine. Other ratios have been applied to the determination of the atomic weight of sulphur, but they are hardly applicable here. The earlier results of Berzelius were wholly inaccurate, and his later experiments upon the synthesis of lead sulphate will be used in discussing the atomic weight of lead. Erdmann and Marchand determined the amount of calcium sulphate which could be formed from a known weight of pure Iceland spar; and later they made analyses of cinnabar, in order to fix the value of sulphur by reference to calcium and to mercury. Their results will be applied in this discussion towards ascertaining the atomic weights of the metals just named. For our present purposes only three ratios need be considered.

First in order let us take up the composition of silver sulphide, as directly determined by Dumas, Stas, and Cooke. Dumas'† experiments were made with sulphur which had been thrice distilled and twice crystallised from carbon disulphide. A known weight of silver was heated in a tube in the vapour of the sulphur, the excess of the latter was distilled away in a current of carbon dioxide, and the resulting silver sulphide was weighed.

I subjoin Dumas' weighings, and also the quantity of Ag_2S proportional to 100 parts of Ag, as deduced from them:—

9·9393 grm. Ag	= 1·473	S	Ratio, 114·820
9·962 "	1·4755	"	" 114·811
30·637 "	4·546	"	" 114·838
30·936 "	4·586	"	" 114·824
30·720	4·554	"	" 114·824

Mean, 114·8234 ± 0·0029

Dumas used from ten to thirty grms. of silver in each experiment. Stas,‡ however, in his work, employed from sixty to two hundred and fifty grms. at a time. Three of Stas' determinations were made by Dumas' method, while in the other two the sulphur was replaced by pure sulphuretted hydrogen. In all cases the excess of sulphur was expelled by carbon dioxide, purified with scrupulous care. Impurities in the dioxide may cause serious error. The five results come out as follows for 100 parts of silver:—

114·854
114·853
114·854
114·851
114·849

Mean 114·8522 ± 0·0007

The experiments made by Professor Cooke‖ with reference to this ratio were only incidental to his elaborate researches upon the atomic weight of antimony. They are interesting, however, for two reasons: they serve to illustrate the volatility of silver, and they represent, not syntheses, but reductions of the sulphide by hydrogen. Cooke gives three series of results. In the first the silver sulphide was long heated to full redness in a current of hydrogen. Highly concordant and at the same time plainly erroneous figures were obtained; the error being eventually traced to the fact that some of the reduced silver, although not heated to its melting-point, was actually volatilised and lost. The second series, from reductions at low redness, are decidedly better. In the third series the sulphide was fully reduced below a visible red heat. Rejecting the first series we have from Cooke's figures in the other two the subjoined quantities of sulphide corresponding to 100 parts of silver:—

7·5411 grms. Ag_2S	lost 0·9773	S.	Ratio, 114·889
5·0364 "	0·6524	"	" 114·882
2·5815 "	0·3345	"	" 114·886
2·6130 "	0·3387	"	" 114·892
2·5724 "	0·3334	"	" 114·891

Mean 114·888 ± 0·0012

1·1357 grm. Ag_2S	lost 0·1465	S.	Ratio, 114·810
1·2936 "	0·1670	"	" 114·823

Mean 114·8165 ± 0·0044

Now, combining all four series, we get the following results:—

Dumas	114·8234 ± 0·0029
Stas	114·8522 0·0007
Cooke's 2nd	114·888 0·0012
" 3rd	114 8165 0·0044
General mean ..	114·8581 + 0·0006

Here again we encounter a curious and instructive compensation of errors, and another evidence of the accuracy of Stas.

(To be continued.)

* *Ann. Chem. Pharm.*, 113, 28. 1860.
† *Ibid.*, 113, 24. 1860.
‡ "Aronstein's Translation," p. 179.
‖ *Proc. Amer. Acad. Arts and Sciences*, vol. xii., 1877

THE CITY CHEMICAL TRADES.

A MEETING of gentlemen interested in the chemical trades of London was held on July 23 at the offices of the London Chamber of Commerce, 84 and 85, King William Street, E.C. There were present Messrs. T. Farmer Hall, W. Caudery, W. Tennant, J. G. Johnson, John T. C. Winkfield, W. G. Blagden, John Blott, D. W. Greenhough, Thomas Tyrer (May and Baker), A. C. Wootton, Bernard Dyer, H. R. Smith and J. Denham Smith (Teschemacher and Smith), G. Bennett, L. A. Bennett, Herbert G. Bennett, David Howard, J. Hartford (Burgoyne, Burbidge, and Co.), Geo. Wigner (Wigner and Harland), G. H. Ogston, V. H. Cannon, and Kenric B. Murray, Secretary.

The meeting decided that the chemical trades should be divided into four sections:—The first, composed of analytical chemists and scientific societies; the second, of chemical manufacturers; the third, of chemical merchants, brokers, &c.; and the fourth, of drysalters and druggists. The names of thirty firms were then submitted to form a committee. The following were elected, it being understood that most of the nominees accepted:—Messrs. G. H. Ogston; J. Hughes; Wigner and Harland; Teschemacher and Smith; Bernard Dyer; F. Manning; May and Baker; Howards and Sons; Pontifex and Wood; Thomas Farmer and Co.; James Gibbs and Co.; Odam's Manure Company; Lawes' Chemical Manure Company; Johnson, Matthey, and Co.; Johnson and Sons; Spence, Chapman, and Co.; John Blott; Hopkin and Williams; Astley P. Price; C. Tennant, Sons, and Co.; Pokorny, Fielder, and Co.; Geo. Bennett and Son; G. M. Bauer; D. W. Greenhough; Blagden and Angus; W. Caudery and Co.; G. J. Saunders; Geo. Atkinson and Co. The list of drysalters was not completed, nominations for this section being left to a future date.

The Committee then nominated Mr. David Howard Chairman of the Section, and Mr. John Blott, Vice-Chairman; and it was decided to hold a general meeting of the whole of the chemical trade of London, both of

those who were not members of the Chamber but would be willing to qualify as such, and of those who were already members, on Monday, July 30, at 2 o'clock.

NOTICES OF BOOKS.

Agricultural Chemical Analysis.. By Percy Faraday Frankland, Ph.D., B.Sc., F.C.S. Founded upon "Leitfaden für die Agrikultur Chemische Analyse," von Dr. F. Krocker. London: Macmillan and Co.

Manuals of chemical analysis as specially applied to agriculture have not, like elementary treatises on general chemistry, multiplied to the utter despair of reviewers; nevertheless the author of the work before us does not enter upon an untrodden field. It comes into competition especially with Prof. Church's well-known "Laboratory Guide," which covers almost identically the same ground.

The responsibility of this book appears to be divided. The author, as he tells us in his preface, set out with the intention of giving merely a translation of Dr. F. Krocker's work. He then judged it desirable to omit almost entirely those parts of the latter which treat of the general principles of chemical analysis as to extend the more strictly agricultural portion. He has further availed himself of the "French Handbook of Agricultural Chemical Analysis" by Prof. Grandeau, which, however, to judge from a footnote on p. 196, he appears to have consulted in a German translation.

The first point that strikes us on an examination of this book is the somewhat needless liberality in the use of formulæ. Surely in a book on chemical analysis, and especially in one where the reader is "assumed to be already conversant with general principles," formulæ are called for only where they may serve as a kind of shorthand, where they may identify some compound more precisely than could be done in words, or where they show in brief the percentage of some constituent.. But here we find occasionally structural formulæ which badly answer this latter purpose, even sometimes superadded to empirical formulæ. For instances of the space thus taken up we may refer to pp. 8, 28, 30, 39, 67, 185, 188, &c. Whatever value such formulae may possess they seem here out of place.

Turning to the subject-matter of the work it would be more than singular if the methods of procedure and other instructions here laid down were not fully on a level with the knowledge of the present day. A few points, however, may require discussion. On p. 201 we find a useful classification of manures according to the ingredients of agricultural value which they contain. Here, among the "phosphoric acid and potash" manures we find mention of coal-ash. Yet on turning to p. 146 we see the potash in coal-ash given as 0·22 per cent., and the phosphoric acid has a "trace," whilst on p. 145 it is stated that "the ashes of coal are of value as manure on account of the sulphuric acid and soluble silica which they contain."

In the instructions for alkalimetry and acidimetry we find no metion of dimethylaniline-orange, or the alcoholic solution of amido-azobenzene as indicators. Cochineal figures here as "cochenille," which is certainly not the English way of writing the name of this dye-ware.

The section on the estimation of ingredients prejudicial to the fertility of a soil is of great value, the more as the search for and determination of such agents is often overlooked. The author enumerates here common salt in quantities exceeding 0·1 per cent, ferrous oxide and sulphur when existing as metallic sulphides or in organic combinations. Other sterilizers will doubtless be recognised where industrial refuse and the sewage of manufacturing towns finds its way upon the land.

In speaking of the methods of incinerating organic matter, Mr. Frankland recommends the addition in certain cases of baric hydrate. This method is undeniably useful, but we would submit that barium peroxide is still more efficient.

On the analysis of milk the author gives a somewhat uncertain sound, declaring that it is not always possible to ascertain by analysis whether the poverty of milk is due to artificial or "natural causes." Here he certainly disagrees with some chemists who have given this subject their especial attention, and he overlooks, apparently, the fact that milk, as offered for sale in our large towns, is not the product of a single animal but of a herd, and may consequently be expected to form a general average. He states, indeed, on the authority of Grandeau, that the water in milk may vary between 80 and 88·65 per cent, the nitrogenous solids (caseine and albumen) from 3·30 to 5·55, and the milk sugar from 3 to 5·50. But he does not say whether Grandeau finds that a low percentage of caseine is accompanied by a correspondingly low proportion of milk-sugar, or that, on the contrary, a compensation takes place, the rise of one of these constituents implying a fall of the other. In other words he gives no opinion as to the constancy of the "solids not fat"—a feature which, indeed, he entirely ignores. He gives no indications for the detection of borax and salicylic acid, bodies understood to be occasionally added to milk not as true adulterants, but to prevent it from turning sour. We are glad to find that Mr. Frankland gives no countenance to the lactometer the creamometer, and such pseudo-scientific playthings.

We next turn to butter. Here the author quotes a table to show the typical composition of the butters of different countries. We are rather surprised to see that in the two English samples fat, casiene, and water make up the full 100 per cent without any salt being present. This is remarkable, since in good fresh butter, the salt is really below 1 per cent, whilst in some samples it reaches 10 per cent. It is distinctly stated here that inferior butters are now largely adulterated with lard, tallow, oleomargarine, &c. But no method is given for their detection. We can only conclude that Mr. Frankland regards the various processes devised for this purpose, based upon the specific gravities, the solubilities, volatilities, melting-points, &c. of the fats as utterly untrustworthy. His scheme for the examination of butter extends only to water, fat (as a totality), caseine and ash, sugar, and salt. Sugar, we may mention, is not noted as occurring in any of the samples analysed by Grandeau.

The analysis of water occupies sixty pages, or very nearly one-fifth of the entire book,—an extent which the author admits is greater than "might at first appear warrantable." He seeks, however, to justify the prominence given to this subject as follows—"The services which water-analysis can render to agriculture are of the greatest importance, for by frequent analysis of the drainage water flowing from his fields the farmer is enabled to ascertain whether or not his soil is being impoverished by the method of drainage he has employed, whilst by the analysis of liquid manures he is able to estimate the agricultural value of any system of irrigation."

To these arguments it may be replied that the agricultural value of any system of irrigation depends mainly on the climate. The greater or more uniform the rainfall and the less the evaporation the more concentrated and the less soluble the manures applied must evidently be, if their valuable constituents are not to disappear in the drainage. Hence in so cold and moist a country as England, where water, for most crops and in most seasons is the *summum malum*, systems of irrigation are best left alone.

The preliminary instructions for the collection of samples are full and useful, though differing merely in language from the directions given by Mr. Wanklyn in his treatise on water-analysis. In determining total dissolved matter Mr. Frankland uses from ¼ to ½ litre. We are glad to find that he does not overlook the possible presence of phosphoric acid, an impurity—from the sanitary point of view—which has been neglected by many authorities, but which, according to our own experience, is by no means

uncommon, and which in wells and drinking-waters generally is of grave significance.

The determination of ammonia is directed to be performed by the Nessler process, but no mention is made of Mr. Hadow and Dr. Miller, who first rendered this test quantitative.

For the estimation of nitrites, Mr. Frankland recommends one of the methods of Griess, that based upon the reaction of metaphenylene-diamine with nitrous acid, when a yellow colour is produced.

The determination of nitric acid or nitrates is described at great length, the preference being evidently given to the indigo-process as modified by Mr. Warington. The determination of the albumenoid ammonia or organic nitrogen by the process of Wanklyn, Chapman, and Smith, is completely ignored. The estimation of total organic matter as loss on ignition is—in our opinion very wisely—omitted. Overlooking all other considerations the mere fact that certain organic compounds may be volatilised or seriously modified before all water of hydration is driven off, deprives this process of all scientific value.

In his account of the determination of organic matter by the permanganate process, or as he calls it the Forchammer or oxygen process, the author makes no mention of the improvement of Kübel, who applies the solution at a boiling heat and thus obtains, at a less outlay of time, a more complete oxidation. In the cold we have found living organisms retain their vitality for hours in the presence of a large excess of potassium permanganate. The determination of the free oxygen in water by the hydrosulphite process is not mentioned. For the determination of lead and copper in water the author recommends the colorimetric process as originally devised by W. A. Miller, and as described by Mr. Wanklyn. Instead of ammonium sulphide he uses a saturated solution of sulphuretted hydrogen. Arsenic he detects by the Marsh process, but chromium, which is a very probable ingredient in the sewage of manufacturing towns, he overlooks. For the detection of barium he recommends a solution of calcium sulphate, a decidedly safer reagent than sulphuric acid. Attention may here be called to the use of strontium in the arts, since, though not poisonous, it might, on a superficial examination, be mistaken for barium.

The determination of organic carbon and organic nitrogen in water by the combustion-process is finally given. As an appendix follow tables of symbols and atomic weights, of the percentages of pure sulphuric, hydrochloric, and nitric acids in the aqueous acids of different specific gravities, and also of caustic potash, soda, and actual ammonia in aqueous solutions.

For several substances, such as soot, commercial sulphate of ammonia, certain compound manures, *e.g.* phospho-guano, and compound cattle-foods and condiments, no special instructions are given. On the other hand, the complete analysis of tobacco is given in full detail.

With some insignificant exceptions this work may be pronounced a safe and useful guide for the student of agricultural chemistry. In the next edition we should recommend the introduction of an index.

CORRESPONDENCE.

CHEAP ANALYSES.

To the Editor of the Chemical News.

SIR,—Some time ago I received from the Clerk of a suburban Local Board, a letter requesting me to let him know my fees for water analysis. A tabular statement of my charges for examinations, ranging from such a qualitative investigation as might serve to afford a preliminary notion regarding the purity of a water to the more elaborate examination which is necessary when the fitness of a water for dietetic uses is seriously questioned, was sent to him; and after about ten days a letter arrived suggesting that I should, "under the circumstances," perform the analyses for 10s. 6d. each. A further perusal of the letter revealed that the "circumstances" were as follows:—A gentleman, whose name was previously unknown to me, but who puts F.C.S. and F.I.C. after his name, had been in the habit of doing the following work for 10s. 6d. per sample; and orders for the closing of certain wells in the parish had been obtained on the strength of his analyses:—

Work done for 10s. 6*d.*

Estimation of total solids.
Estimation of free ammonia.
Estimation of albumenoid ammonia.
Estimation of chlorine.
Estimation of total hardness.
Estimation of permanent hardness.
(Temporary hardness by difference)
Qualitative examination for lead, &c.
Written opinion or report as to fitness of water for domestic use.

Although the work of testing for lead alone, including the necessary precautions for guarding against the accidental introduction of traces of metals of the first group, would, in the hands of a careful chemist, take considerably over twelve hours: let us assume that the whole of the work could be performed with *moderate care* in eleven or twelve hours. This would provide for remuneration to the analyst at the rate of something less than one shilling per hour, or about the same as earned by a bricklayer; while, if we assume that the analysis is performed with anything like the care and attention to detail which is considered necessary during original research, the sum realised by the cheap analyst would dwindle down to three or four pence per hour.

Many circumstances have tended of late to inaugurate a system of cheap and hastily performed analysis, the rates charged varying from one-eighth to one-twentieth of the fees which would be paid to a chemist of position; and the whole subject of cheap analysis—their almost universal failure when further investigation is made—the astonishing deductions drawn from them—and their forensic bearing, might well be discussed with detail in the columns of the CHEMICAL NEWS.—I am, &c.,

THOMAS BOLAS.

July 21, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 2, July 9, 1883.

Pyro-electricity in Blende, Sodium Chlorate, and Boracite.—C. Friedel and J. Curie.—The authors conclude that in hexagonal substances having three horizontal axes of hemi-morphism, and in cubic substances belonging to the type of tetra-hedric hemihedrism, when there is regular cooling or heating of the crystal, *i.e.*, when the expansions are equal in respect to the different axes in question, there is compensation from a pyro-electric point of view, and no disengagement of electricity is observed. It is obtained, on the contrary, when an irregular variation of temperature, or a compression affecting certain axes more than others produces unequal expansion.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Ultra-red Emission Spectra of Metallic Vapours.—Henri Becquerel.—The method of observation which the author describes opens up a new field in spectral analysis, comprising, between the wave-lengths 760 and 1300, an interval of wave-lengths greater than that existing between the extreme red of the visible spectrum and the last of the known violet rays.

Novel Method for Determining the Limits of Electrolysis.—Ch. Truchot.—The author founds his method upon M. Berthelot's law that "the decomposition of electrolytes is effected as soon as the smallest sum of the necessary energies, foreseen according to the quantities of heat, is present. In this manner, from the limits of the electromotive forces employed, it is possible to deduce the quantities of heat necessary to effect decompositions. We have thus a means of determining or of verifying certain formation heats.

On Samarium.—P. T. Clève.—See page 39.

Blue Colouration obtained by the Action of Chromic Acid upon Hydrogen Peroxide.—H. Moissan.—The compound formed is not, as was supposed by Barreswil, perchromic acid, but a compound of chromic acid with hydrogen dinoxide, CrO_3HO_2.

Tetric Acid and its Homologues.—W. Pawlow.—The author shows that the tetric acid of Demarçay may be regarded as acetylic acrylic acid.

Dimorphism of Silver Iodide.—MM. Mallard and Le Chatelier.—The authors show that silver iodide undergoes a change of state similar to that of boracite.

New Reactions characteristic of the Salts of Gold.—Ad. Carnot.—If we pour into a small phial a few drops of a dilute solution of gold chloride, some drops of arsenic acid, two or three drops of ferric chloride, and the same quantity of hydrochloric acid, and about 100 c.c. of water, and introduce a fragment of zinc, the liquid soon takes a purple colour in the neighbourhood of the zinc, and on shaking takes throughout a fine rose or purple colour. The experiment thus conducted may last for half an hour, but it is completed in a few moments if we use some centigrammes of zinc-powder and shake the phial. The rose colouration is also immediate if we pour into the solution of the salt of gold, prepared in the same manner, some drops of the liquid obtained by attacking metallic iron with dilute hydrochloric acid, or, better, by heating it with a mixture of hydrochloric acid and arsenic acid. It is diluted with water, and left in contact with an excess of metal. This reaction is extremely sensitive. If one-millionth part of gold is present the change of colour is very visible, and it may be distinguished even with a proportion of gold one-half less. The author purposes showing at an early opportunity how the same reaction may be applied in quantitative determinations. If phosphoric is used in place of arsenic acid the colouration is blue or violet. Hydrochloric acid alone gives a rose colouration, but less bright than with the addition of arsenic acid.

Sodium Alcoholates.—M. de Forcrand.—A thermochemical paper, in which the author shows that water and alcohol play a part substantially equivalent to each other in presence of soda and of sodium.

Pyrogenation of Resin.—Ad. Renard.—By the destructive distillation of resin at dull redness the author has obtained two new isomeric carbides, for which he proposes the name colophanthrene. The yellow compound is very slightly soluble in alcohol, from which it is deposited on cooling in yellow crystals with a greenish fluorescence. It boils above 360°. The white compound is much more soluble, and is deposited in white brilliant crystals with a violet fluorescence. It melts at 87°, and boils about 360°. Both carbides, if oxidised with chromic acid in acetic solution, yield a diacetone, whilst carbonic acid escapes. This diacetone, if heated with fuming sulphuric acid, gives rise to a sulpho-conjugated acid, the potassium salt of which, if heated to 170° in a sealed tube with a strong solution of caustic potassa, is transformed into a mass of an intense violet colour. If dissolved in water and decomposed with hydrochloric acid it yields a colouring-matter, which on cotton mordanted with alumina dyes a shade similar to that given by alizarin.

Contribution to the Study of Panary Fermentation.—L. Boutroux.—The author refers to the memoirs of M. Chicandard (*Comptes Rendus*, xcvi., p. 1585) of M. Marcano (*Ibid.*, June 11), and of M. Moussette (*Ibid.*, June 25). His own researches, carried out previously to those of M. Chicandard, confirm the theory of the latter as to the principal point, but they agree so far with the phenomena cited by M. Moussette that we may pronounce this theory too exclusive.

Method for Estimating the Value of the Wines of the South.—A. Audoynaud.—The author mixes 5 c.c. of the wine with 10 c.c. of a solution of baryta saturated in the cold. A precipitate is formed, which if washed immediately in boiling water, gives a liquid unstable in the air, readily oxidised, and of a yellowish colour. After having removed the excess of baryta by a current of carbonic acid, and made up the liquid with water to 100 c.c., the proportion of yellow colouring matter may be judged of on oxidising with a standard solution of potassium permanganate. The numbers thus obtained, compared with the alcoholic standard of the wine, enable an opinion to be formed on its value.

Journal de Pharmacie et de Chemie.
Tome viii., July, 1883.

Pharmacological Researches on Methylene Chloride.—J. Regnauld and E. Villejean.—This paper treats on the use of methylene chloride as an anæsthetic in surgical operations.

Analysis of the Mineral Water of Heucheloup.—J. Lefort.—This paper presents no general interest.

Action of Sulphur on the Alkaline Phosphates.—MM. E. Filhol and Senderens.—Finely divided sulphur has no appreciable effect upon solutions of potassium and sodium phosphate at common temperatures. At 100° there ensues formation of alkaline poly-sulphides and hypo-sulphites. The trisodic phosphate is converted, first into a disodic, and ultimately into a sesquisodic salt. The authors hence regard phosphoric acid as a sesquibasic acid of mixed functions.

Variations in the Composition of Semen in Pathological Cases.—C. Méhu.—A medical paper.

Cultivation of the Cacao. Researches on the Constitution of Cacao Beans and of Chocolate.—M. Boussingault.—The nature of this memoir appears sufficiently from its title.

Intestinal Sand.—M. Yvon.—Analyses of a sandy concretion voided in certain pathological cases.

Balloons of Oxygen.—E. Godin.—The author proposes to send out oxygen gas in toy balloons, to be inhaled as a remedy for asthma.

Analysis of a Salivary Calculus.—A. Mallat.—Of merely medical interest.

Cupric Solutions employed in the Detection of Glucose.—M. Sonnerat.—The author prepares his solution as follows:—Dissolve to saturation in the cold, and in distilled water, 34·639 grms. copper sulphate, pure and crystalline. In another vessel dissolve, also in the cold, in 600 grms. caustic soda-lye (of sp. gr. 1·12), 173 grms. potassium tartrate, chemically pure and crystalline. To this alkaline liquid add, little by little, the cold solution of copper sulphate, and dilute the whole to 1 litre.

The Cadmium-potassic Reagent.—M. Lepage.—The author dissolves in 50 grms. distilled water, 2·8 grms. cadmium iodide and 2·5 grms. potassium iodide, and filters the solution. A few drops of this reagent produce a marked turbidity, or even a precipitate in solution of crude

opium, extract of opium, extract of yellow cinchona, extract of nux vomica, and tincture of cinchona.

Paraffin Exsiccator.—M. Liebermann.—For substances dissolved in carbon disulphide, ether, chloroform, &c., the author uses an exsiccator in which paraffin is substituted for sulphuric acid. Paraffin absorbs its weight of carbon disulphide in four or five hours, ether in eight or nine hours, and chloroform in nine to ten hours. These liquids are then recovered by distillation.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 5.

Colour of Water.—W. Spring.—Pure water has in itself a blue colour if observed in a stratum of sufficient thickness. In natural waters which appear blue calcium and magnesium carbonate, silica, and alumina exist in solution. In green waters the same salts exist, from deficiency in carbonic acid, in imperfect solution, or in partial suspension.

Influence of Temperature and Rainfall upon the Wheat-Crop.—A. v. T.—The author shows that the wheat-crop is mainly determined by the state of the weather in July and August—the higher the temperature in those two months, and the smaller the rainfall, the better being the harvest. The author's conclusions are based upon English statistics extending over thirty-six years. The best harvest was that of 1868, with a temperature for the two months of 4·1° F. above the average, and a rainfall of 2·71 inches below the average, but the worst was that of 1860, with a deficiency of temperature of 4·6° F., and an excess of 2·6 inches of rain. In 1879 the deficiency of temperature was only 2·8° F., but the excess of rainfall was 4 inches.

NOTICE.

THE BADISCHE ANILIN AND SODA FABRIK, of Stuttgart and Ludwigshafen on Rhine, Hereby Give Notice that they have instructed their Solicitor to take legal proceedings against all persons making, selling, or using any NAPHTHOL-YELLOW, patented 29th December, 1879, No. 5305, not manufactured by the Company.

All packages or tins of the genuine Dye bear the Patent Labels and Trade Mark of the Badische Anilin and Soda Fabrik.

Information as to infringements of the above Patent is to be given to Messrs. Schott, Segner, and Co., 4, Charlotte Street, Manchester, or Mr. H. Beck, 22, Bush Lane, Cannon Street, London, E.C.

Dated 16th July, 1883.

(Signed) J. HENRY JOHNSON,
47, Lincoln's Inn Fields, London,
Solicitor for the said Company.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

MUNRO SCOTT, Warden.

LEEDS MECHANICS' INSTITUTION and LITERARY SOCIETY.—Wanted, from the 10th September next, a SCIENCE MASTER for the Day and Evening Classes in connection with the above Institution. He will be required to teach Theoretical and Practical Inorganic and Organic Chemistry and Metallurgy. Previous practical training in chemical analysis indispensable. Fixed salary £200 per annum, with share of results, which during the past two years have produced an average of £100 per annum—Applications, with full particulars and testimonials (not more than three in number), to be addressed to the Secretary, Cookridge Street, Leeds, not later than Saturday, August 11th.

W. J. NEILD,
C. ENGLAND, } Hon. Secs.

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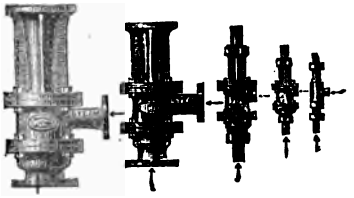

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1236.

ON THE
CONSTITUTION OF THE NATURAL FATS.

By J. ALFRED WANKLYN and WILLIAM FOX.

IN the course of an investigation in which we are at present engaged we have arrived at some results which appear to us to be very interesting. We find that the generally received view that the fats are ethers of glycerin is partially correct, and that instances of a different kind of structure occur among the natural oils and fats.

Ethers of iso-glycerin, or of homologues of iso-glycerin, appear to occur. Iso-glycerin has this structure :—

$$\begin{matrix} C(OH)_3 \\ CH_2 \\ CH_3 \end{matrix}$$

It exists in its ethers, but cannot be isolated, and should be resolved into :—

$$\begin{matrix} COOH + H_2O \\ CH_2 \\ CH_3 \end{matrix}$$

Ethers of iso-glycerin, or ethers of homologues of iso-glycerin, yield no glycerin when saponified.

July 26, 1883.

ON THE
IDENTIFICATION OF MINUTE QUANTITIES OF SILVER CYANIDE.

By C. L. BLOXAM.

IF a particle of precipitated silver cyanide be examined by the microscope with a quarter-inch objective it appears as an amorphous mass, but if a drop of ammonia be placed upon it, and very gently warmed, it will form very distinct needle-like crystals. Silver chloride treated in the same way gives very minute octahedra. In a mixture of silver cyanide and silver chloride both constituents may be identified in this way. When the silver cyanide is present in very small proportion the silver chloride forms strings of minute octahedra, interspersed with the needles of silver cyanide.

In the ordinary course of qualitative analysis, where the cyanide and chloride are precipitated together by silver nitrate from a solution acidified with nitric acid, this test is found useful. Silver sulphocyanide forms needles when treated in the same way, but the absence of a sulphocyanide can be ascertained by the ferric chloride test. Silver cyanide is also deposited in minute needles when boiled with a strong solution of sodium carbonate and allowed to cool. Unless the boiling be prolonged but little of the cyanide is decomposed.

When precipitated silver cyanide is boiled with dilute nitric acid (sp. gr. 1·2) it is dissolved, and on cooling is deposited, sometimes in a semi-transparent gelatinous form, and at others in white masses, which are seen under the microscope to consist of beautiful stellate groups of needles. Similar groups may be obtained by moistening precipitated silver cyanide with strong nitric acid on a glass slide, and gently warming.

If the solution of silver cyanide in hot dilute nitric acid be cooled in a test-tube, under the water-tap, its behaviour is quite characteristic: if the test-tube be kept still the cyanide separates in the semi-transparent gelatinous form, but, on gently shaking, this collects suddenly into opaque masses, which generally appear as groups of needles under the microscope.

When silver cyanide is precipitated together with silver chloride, it may be separated by boiling the mixed precipitate with nitric acid, filtering while hot, and cooling the solution. The deposited silver cyanide may be finally tested by heating it with yellow ammonium sulphide, evaporating the solution of ammonium sulphocyanide thus obtained, and testing with ferric chloride.

King's College, London,
July 26, 1883.

ON THORIUM SULPHATE.

By EUG. DEMARCAY.

M. NILSON has published in the *Comptes Rendus* (xcv., pp. 727, 729, and 783, and xcvi., p. 346), a series of memoirs on the thorite of Arendal and on thorium sulphate. The author, having been engaged for some time upon the same subject, has arrived at similar conclusions as regards the composition of thorite and almost the same concerning the purification of thorium. It is, however, possible to obtain an almost perfect separation of thorium and the metals of cerite and gadolinite by the alternate application of the methods of fractionated crystallisation, and of dissolving thorium oxalate in ammonium oxalate (*Vogel, Praktische Spectral Analyse*, p. 152). But the study of thorium sulphate has led to different results. M. Nilson admits that thorium sulphate possesses a solubility which decreases with a rising temperature, basing this conclusion probably on the ready solubility of the anhydrous sulphate in cold water, and the almost complete precipitation of the thorium at the boiling-point. But as the anhydrous sulphate is converted into hydrates in presence of water, so that these only can come in question, and accordingly as we consider the one or the other hydrate, the solubility may be very different at one and the same temperature; finally, at 100° pure water decomposes thorium sulphate.

A dilute and neutral solution of thorium sulphate (1 per 1000) if submitted to the action of heat becomes gradually turbid, and at 100° there is formed a flocculent basic salt, as may be easily found on its isolation; 0·1 grm. of sulphuric acid per litre of water prevents its formation. This dissociation by water, barely perceptible in the cold, is very manifest in heat. The auther has not completed the analysis of this salt. Hot water acts differently upon concentrated solutions. The hydrate containing 9 mols. of water if mixed with ten or fifteen times its weight of water is converted at 60° into a mass of a cotton-like appearance which a temperature of 100°, if kept up for 24—48 hours, transforms into a pulverulent precipitate, which is no longer soluble in the cold. The salt thus formed is basic, and answers to the formula—

$$3\,[Th(SO_4)_2,2H_2O + Th(SO_4)O,2H_2O].$$

The quantity of sulphate remaining in solution is minute, scarcely 0·1 to 0·2 per cent under the above conditions and varying with the quantity of water present. A notable quantity of free acid (3 to 4 per cent) greatly hinders the formation of this basic salt. In presence of little water little of the salt is produced. Basic thorium sulphate is scarcely attacked by cold water, and even the acids act but slowly.

The solubility of the various hydrated sulphates is very different; their solutions are easily supersaturated, which renders their study the more tedious. The solubility of the hydrate with 9 mols. of water increases regularly with the temperature; 100 grs. of the solution at 0° contain 1·2 grm. of the hydrated salt, but at 54° 8 to 9 grms. Above 55° thorium sulphate possesses a very considerable solubility, but a saturated solution cannot be formed without turbidity, owing to a deposit of the cotton-like hydrate, which takes place rapidly at 60°.

The other hydrates of thorium sulphate are much less known. The author has studied the hydrate with 4 mols. of water which had been previously obtained by Chydénius and which is probably identical with Delafontaine's hydrate with 4½ mols. of water. He obtains this hydrate pure and constant in composition by keeping the hydrate with 9 mols. at 100° in presence of water containing 5 per cent of sulphuric acid. As regards the solubility of this hydrate 100 grms. of the solution contain at 17° 8 6 grms. of the anhydrous sulphate, but at 100° only 0·3 grm. Below 17° it is impossible to saturate the solution without the hydrate containing 9 mols. of water being deposited. —*Comptes Rendus.*

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tellurium.—The liquid containing tellurium in the state of tellurous acid is mixed in the cold with a sufficiency of hydrochloric acid and saturated in the cold with sulphuretted hydrogen. Tellurium sulphide is precipitated, whilst the gallium is found in the filtrate, which is not, however, always absolutely free from tellurium. In an accurate analysis the clear liquid should therefore be boiled for some minutes, whilst a current of hydrogen sulphide is passed through it, and the slight traces of tellurium sulphide obtained by this second operation are collected on a filter. When the volume of the filtrate is considerable, it is preferable to begin by concentrating to a small bulk before treating with sulphuretted hydrogen in heat.

Separation from Silica.—If free sulphuric acid exists in the liquid it is strongly acidified with hydrochloric acid and evaporated to dryness, at first at 100°; then, when all visable traces of liquid have disappeared the residue is kept for fifteen to twenty minutes at 120°-125°.

When cold the mass is moistened with dilute hydrochloric acid and evaporated to dryness a second time in the same manner.

The mixture of silica and the salts of gallium is sprinkled with a little hydrochloric acid, and then heated to 100° for some minutes, in order to dissolve entirely the gallium oxychlorides, which have been formed during desiccation. Care must be taken that no part of the matter is now dried up. Water is then added and the liquid is heated to near the boiling-point whilst being stirred.

The silica is then collected upon a filter and washed for a long time, at first with water acidulated with hydrochloric acid, and then with pure water. The gallium is easily extracted from the filtrate by expelling the greater part of hydrochloric acid by evaporation and precipitating with cupric hydrate.

Whatever care has been taken in washing the silica it retains almost always slight traces of gallium. In an exact analysis, especially if the quantity of silica is large, it must be re-dissolved in potassa, supersaturated with hydrochloric acid, and treated again as above.—*Comptes Rendus.*

The Digestion of Cows' Milk, and the Means of Increasing its Digestibility.—Prof. J. Uffelmann.—The precipitate of caseine produced by dilute hydrochloric acid can be re-dissolved by the addition of a certain quantity of the same acid. Lactic acid does not re-dissolve the precipitate which it at first occasions. Boiled milk is not increased in digestibility by the process, though the author recommends boiling as destructive to ferments and germs. Butter-milk is preferable to sweet milk as an article of diet, the lactic acid being first neutralised with lime-water. An addition of barley-water (1 part to 2 of milk) greatly increases digestibility. A child fed upon this mixture was found to utilise 99·75 per cent of the albumenoids, 96 6 of the fatty matter, and the whole of the sugar.—*Biedermann's Centralblatt.*

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS.

I. The Analysis of Soap.

In the analysis of soap it is necessary to determine:—

1. Water; 2. Uncombined fat; 3. Soap, consisting of (3*a*) combined fatty acids and (3*b*) combined alkali, usually soda (Na_2O); 4. Uncombined alkali; 5. Glycerine; 6. Resin; 7. Sodic carbonate: 8. Sodic chloride; 9. Sodic sulphate; 10. Sodic silicate, consisting of (10*a*) soda combined in silicate, (10*b*) silica; 11. Starch; 12. Insoluble residue or mineral impurities, such as talc, clay, ochre, sand, &c.

Methods of Analysis.

Various methods have been proposed, which can be best understood by presentation in the original language of their authors, along with such comments as have been suggested by my own experience. These notes are bracketed to distinguish them from the original text. In conclusion, I have ventured to propose a new method, which has been found to give accurate and rapid results, and has the advantage of reducing the performance of a soap analysis to a few consecutive operations and one weighing of the original sample.

Method I. (Published by C. F. C. in the Chemical News, vol. xxxv., p. 2.)

Weighing.—In all methods usually given in text-books the analyst is directed to weigh out for each operation small portions (1 to 5 grms.) of the sample. This plan is to be avoided, and for two reasons: 1. Soap is extremely variable in composition, and considerable variations are possible even in the same sample. 2. It is perpetually losing water by evaporation from its surface As the soap is usually weighed in the form of thin shavings, the surface exposed is, in relation to the weight taken, very considerable.

[When the variations in composition are so excessive, analyses of more than one sample are necessary. With reasonable care the weight does not alter so rapidly in making thin shavings as to produce an appreciable error.—L.]

These two sources of inaccuracy are obviated by weighing out for the analysis a section cut through the bar at right angles to its length (60 to 80 grms.), dissolving in distilled water, and making the volume up to 1000 c.c. (in the cold); 50 c.c. of this solution are measured off for each operation. It should be observed that as some of the alkaline salts of the fatty acids separate out from the solution on cooling, it must be well mixed, by agitation, previously to drawing off each 50 c.c. The several operations are conducted as follows:—

1. *Total Alkali.*—50 c.c. of the solution are diluted to about 200 c.c., the liquid is coloured faintly with eosine, and standard acid is run in, taking care to stir briskly with a glass rod. The neutral point is extremely well marked by the sudden decolouration of the whole. The cause of this apparent destruction of colour is the union of the fatty acids with the eosine at the moment of their complete separation from the fluid.

2. *Uncombined Alkali.*—50 c.c. are added to 300 c.c. of a saturated solution of common salt, which must be, of course, neutral to test-paper, and the volume made up to 400 c.c. The neutral alkaline salts of the fatty acids (*i.e.*, true soap) are precipitated; any excess of alkali present remains in solution; this is determined in an aliquot part of the filtered solution; the filter must not be moistened previous to filtration; from this the total uncombined alkali is calculated, and subtracted from the *total alkali* already found. Then the *combined* and *uncombined* alkali are determined.

3. *Fatty Acids.*—50 c.c. of this solution are introduced into a stoppered separating funnel, decomposed with ex-

cess of acid, and agitated with carbon disulphide until the liberated fatty acids are dissolved. The disulphide solution of the fats is drawn off into a tared flask; the aqueous solution is washed once or twice with small portions of disulphide, the whole of which is then separated from the fats by distillation. The fats are purified from the last traces of CS_2 by heating the flask for a short time at 100° C.; the weight, after cooling, less the tare, gives the weight of the fatty acids. Ordinary ether may be used in place of the CS_2; it has, however, the disadvantage of retaining small quantities of water, and therefore aqueous acids, which must be driven off at the end of the operation by exposing to a temperature of 100° to 120° C., until the weight is constant. Further, the ethereal solution will be the upper stratum, and is, for obvious reasons, not so easily to be manipulated as the bisulphide solution, which forms the lower layer.

[The solution of the combined fatty acids in carbon disulphide is unnecessary, since they can be directly determined in the manner detailed further on.—L.]

Note.—A moment's consideration of the following equation, representing the decomposition of sodic oleate by HCl,—

$$2\left\{C_{18}H_{33}O_{Na}^{O}\right\}O + 2HCl = 2NCl + 2\left\{C_{18}H_{33}O_{H}^{O}\right\}O,$$

will make it evident that while the fatty acid is present in the soap in the form of anhydride, it is separated and weighed in the course of analysis as hydrate. A correction must therefore be applied, based upon the fact that 282 parts oleic hydrate = 273 parts oleic anhydride, *i.e.*, the weight of the fatty acids is to be multiplied by the decimal fraction 0·97.

In the case of the "olein" soaps of commerce, a very rapid and tolerably accurate estimation may be made in the following way:—50 c.c. of the solution are decomposed with HCl in a small flask, the neck of which is long and narrow, and graduated in c.c., and so much water added that, upon heating in the water-bath, the separated oil will rise into the neck and fall entirely within the graduated portion. The heating must be continued, with occasional tapping of the flask, until the whole of the fat has been separated and has risen into the neck. The flask is allowed to cool, and when cool the volume of the oil is read off. This quantity, multiplied by the specific gravity of the oil, gives its weight. The specific gravity (which I have almost always found to be 0·9) may be determined by pouring off a small quantity into a capsule (a second reading will give the volume taken), and weighing it; the weight divided by the volume is the required specific gravity.

4. *Water.*—If the purity of the sample has been ascertained this constituent may be calculated by difference. The direct estimation is effected by evaporating 50 c.c. of the solution to dryness on the water-bath (finally in the air-bath from 100° to 120° C.) in a weighed dish. The residue is anhydrous soap; from its weight the percentage of water in the soap may readily be calculated. It may be observed that the usual method, which consists in the exposure of the soap, previously cut into thin shavings and weighed, to the temperature of boiling water until it ceases to lose weight, is inaccurate, as it fails to drive off the last portions of water (1 to 2 per cent), which seem to have contracted a stronger union with the soap.

[This difficulty is not experienced if the soap is dried at 110° to constant weight. See also remarks by author of Method II.—L.]

5. *Mineral impurities and unsaponified fat* may be detected by taking the dry soap from the preceding operation, dissolving in strong alcohol, and filtering through a funnel heated by means of a jacket of hot water. *Mineral impurities* remain upon the filter as an insoluble residue, the weight of which is readily ascertained. The alcoholic filtrate is evaporated with successive additions of distilled water; by these means any unsaponified fat or resin is separated from the soap, which, of course, remains in aqueous solution. This solution may be used for 1, 2, or 3. The mineral impurities may be examined qualitatively after drying and weighing.

[This method of determining the uncombined fat is tedious and troublesome, and furthermore has the disadvantage of not separating the resin from the fat.—L.]

Method II. (By C. Hope, in CHEMICAL NEWS, vol. xliii., page 219.)

In this paper I intend giving, for the full analysis of soda soaps, a method which I have used for some considerable time, and which I find to be useful in giving information as to how the soap has been made, and also as giving an exact analysis of it, which is much desired by some consumers, and not usually done by analysts. In some cases a much shorter analysis will suffice, but in a soap-works' laboratory the full one will be very often wanted. Before weighing off portions of the soap, I think it is absolutely necessary to cut off the outer skin and take the inside, otherwise discrepancies will result not otherwise to be accounted for. The skin is a very small portion usually of the bar or cake, and it would be a difficult operation to get the proper amount of skin in the different portions weighed.

[As compared with Method I., which necessitates but one weighing of the original sample, this method has the great disadvantage of necessitating no less than seven weighings of the sample, and in quantities varying from 5 to 31 grms. Besides the loss of time thus occasioned, there is a corresponding probability of the various determinations not agreeing among themselves, if the original sample was not uniform.—L.]

Water.—The first thing to be done is to cut some thin shavings of the sample, weighing about 5 grms., and place them in a small tared flat porcelain basin, and the exact weight noted. It is then put in the water-bath and heated until it ceases to lose weight; a night generally suffices for this purpose. When that is done, it is weighed in the morning, and a number of small holes made with a pin in the dried slices, and put in the bath again for a few hours, and re-weighed. If there is no further loss, as is generally the case, it is certain the soap is thoroughly dry. Some chemists have condemned this method of estimating the water, because, they say, it fails to give off the last 1 or 2 per cent; but I find that such is not the case, because when a soap is dried as I have described, it will give no further loss, even if heated to its decomposing-point.

Fatty Acids.—A portion of the soap, weighing about 5 grms., in the form of miniature bars, is introduced into a separating funnel of about 120 c.c. capacity, and about 50 c.c. of water at, say, 100° F. poured in, then enough acetic acid to decompose the soap and leave a small excess, and, finally, about 50 c.c. of ordinary ether. The stopper is then put in the funnel, and the whole shaken until the soap is all dissolved. It is then allowed to settle for a few minutes, when the fatty acids will be found to have dissolved in the ether, and floating on the watery solution, which contains the soda salts, &c. The bottom stopper is then opened slightly, and the watery solution of the salts allowed to *drop* slowly out until it stops; then the top stopper is taken out, and the remainder of the water allowed to drop slowly out until only a few drops remain, at which time the stopper is shut. The funnel is then filled up with water about 90° or 100° F., the stopper replaced and shaken for a minute or so, allowed to settle, and the same operation as before repeated. The washing is continued until the washings are neutral, at which point the last few drops are allowed to go out, taking care not to allow any of the ethereal solution to follow it. It is always necessary to open the bottom stopper first, as there is enough ether vapour in the funnel to cause an outward pressure, which, on opening the top stopper, first causes a few small drops of the ether solution to splutter out—a proceeding not to be desired, and which is effectually prevented by operating as described. The dropping of the washings is to be carefully done, other-

Now, from ratios 1 to 7 inclusive, we can at once, by applying the known atomic weight of oxygen, deduce the molecular weights of seven haloid salts. Let us consider the first calculation somewhat in detail.

Potassium chlorate yields 39·154 per cent of oxygen and 60·846 per cent. of residual chloride. For each of these quantities the probable error is ± 0·00038. The atomic weight of oxygen is 15·9633 ± 0·0035, so that the value for three atoms becomes 47·8899, ± 0·0105. We now have the following simple proportion :— 39·154 : 60·846 : : 47·8899 : x, = the molecular weight of potassium chloride = 74·4217. The probable error being known for the first, second, and third term of this proportion, we can easily find that of the fourth term by the formula given in our introduction. It comes out ± 0·0164. By this method we obtain the following series of values, which may conveniently be numbered consecutively with the foregoing ratios :—

(21.)	KCl,	from (1,)	= 74·4217	± 0·0164
(22.)	KBr,	,, (2,)	= 119·117	0·0962
(23.)	KI,	,, (3.)	= 165·210	0·0529
(24.)	NaCl,	,, (4.)	= 58·366	0·0137
(25.)	AgCl,	,, (5.)	= 143·062	0·0320
(26·)	AgBr,	,, (6)	= 187·453	0·0432
(27.)	AgI,	,, (7.)	= 234·195	0·0530

With the help of these molecular weights we are now able to calculate eight independent values for the atomic weight of silver :—

First,	from (10)	and (21,)	Ag = 107 696	± 0·024
Second,	,, (11)	,, (22,)	,, = 107·948	0·087
Third,	,, (12)	,, (23,)	,, = 107·488	0·037
Fourth,	,, (9)	,, (24,)	,, = 107·671	0·025
Fifth,	,, (13)	,, (25,)	,, = 107·694	0·024
Sixth,	,, (14)	,, (26,)	,, = 107·681	0·025
Seventh,	,, (15)	,, (27,)	,, = 107·659	0·024
Eighth,	,, (8)	,, (16,)	,, = 107·712	0·025
	General mean ..		107·675	± 0·0096

It is noticeable that six of these values agree very well. The second and third, however, diverge widely from the average, but in opposite directions; they have, moreover, high probable errors and consequently little weight. Of these two, one represents little and the other none of Stas' work. Their trifling influence upon our final results becomes curiously apparent in the series of silver values given a little further along.

When we consider closely, in all of its bearings, any one of the values just given, we shall see that for certain purposes it must be excluded from our general mean. For example, the first is derived partly from the ratio between silver and potassium chloride. From this ratio, the atomic weight of one substance being known, we can deduce that of the other. We have already used it in ascertaining the atomic weight of silver, and the value thus obtained is included in our general mean. But if from it we are to determine the molecular weight of potassium chloride, we must use a silver value derived from other sources only, or we should be assuming a part of our result in advance. In other words, we must now use a general mean for silver from which this ratio with reference to silver has been rejected. Hence the following series of silver values, which are lettered for reference :—

A.	General mean from all eight	107·675	± 0·0096
B.	,, rejecting the first ..	107·671	0·0105
C.	,, ,, second..	107·671	0·0097
D.	,, ,, third ..	107·679	0·0100
E.	,, ,, fourth ..	107·675	0·0104
F.	,, ,, fifth ..	107·671	0·0105
G.	,, ,, sixth ..	107·674	0·0104
H.	,, ,, seventh.	107·678	0·0105
I.	,, ,, eight ..	107·679	0·0104

These values are essentially the same, both in magnitude and in weight. For all practical purposes any one of them is as good as any other. Still, on theoretical grounds, it may be well to keep them distinct and separate in the remainder of this discussion.

(To be continued.)

THE CITY CHEMICAL TRADES.

A Special General Meeting of gentlemen interested in the chemical trades was held at the offices of the London Chamber of Commerce, 84 and 85, King William Street, E.C., on July 30th, at 2 o'clock. Mr. David Howard was in the chair, and there were present Messrs. T. Farmer Hall, W. Caudery, J. G. Johnson, G. H. Ogston, J. Denham Smith, H. R. Smith, William Newton (Cannon and Newton), John Blott, Lewis P. Fielder, D. W. Greenhough, W. K. Hopkin, Bernard Dyer, Rudolph Messel, George Pugh, C. Christopherson, W. G. Blagden, H. Lindley Trumann, Geo. Bennett (Geo. Bennett and Sons), H. B. Clarke, Thomas Tyrer, W. M. Ramlett, and Kenric B. Murray, Secretary.

The minutes of the previous meeting were read by the secretary and adopted, and applications from 20 firms interested in these trades were submitted by members present, and recommended for the adoption of the Council of the Chamber. The list of committee, as prepared by the Preliminary Sub-committee, was adopted unanimously, Mr. David Howard being nominated president, and Mr. John Blott vice-president. The names of five firms were added to the Drysalters' and Druggists Sub-section, bringing the total number of members of the committee, including the chairman, to 37.

It was decided to hold the meetings of the section monthly, on the last Wednesday of the month, at two o'clock, and that ten days' notice at least should be given to the secretary of all questions for discussion.

The meeting adjourned till the last Wednesday in October, so as to give the Council time to confirm the proceedings.

The Chemical Section, as now constituted, will be one of the most important and influential in the Chamber, and there is every prospect that it will be able to carry out successfully measures to obtain the adoption of some uniform system of chemical analysis. This is the first object of the section; and it is proposed to discuss this question exhaustively at the earliest possible date, to submit it to Chambers of Commerce throughout the country, and, finally, to draft a Bill to be submitted to Parliament. The revised list of the committee as proposed by the General Meeting is as follows :—

Chairman, David Howard, Esq.; *Deputy-chairman*, John Blott, Esq.

1. *Analytical Chemists' Sub-section.*

Bernard Dyer, F.C.S., F.I.C., 17, Great Tower street, E.C.; John Hughes, F.C.S. (Ceylon Coffee Planters' Association), 79, Mark-lane, E.C.; Fred. A. Manning, 18, Billiter-street, E.C; George Henry Ogston, 39, Lime-street, E.C.; Denham Smith (Teschemacher & Smith), Commercial Sale Rooms, E.C.; G. W. Wigner (Wigner and Harland, F.C.S., F.I.C.), 37, Lombard-street, E.C.

2. *Chemical Manufacturers' Sub-section.*

Blott (J. & J. Blott & Co.), Eagle Chemical Works, Chrisp-street, Poplar, E.; Burt, Boulton, and Heywood, 64, Cannon-street, E.C.; Spencer, Chapman (Chapman, Spencer, & Co.), 36, Mark-lane, E.C.; T. Farmer Hall (Farmer, Thomas, & Co.), Dunster House, Mark-lane, E.C.; J. C. & J. Field, 15, Lambeth Upper Marsh, S.E.; A. E. Ford (Gibbs, James, & Co.) 16, Mark-lane, E.C.; F. C. Hills, (Hills, Clarke, & Co.) 17, Philpot-lane, E.C.; Hopkin and Williams, 16, Cross-street, Hatton-garden, E.C.; David Howard (Howard and Sons), 36, Lombard-

street, E.C.; Geo. Matthey (Johnson, Matthey, & Co.), Hatton Garden, E.C; Johnson, John & Sons, 23, Cross-street, Finsbury, E.C.; Thos. Elborough (Lawes' Chemical Manure Company, Limited), 59, Mark-lane, E.C.; Thos. Tyrer (May & Baker), Garden Wharf, Battersea, S.W.; C. T. McAdam (Nitro-Phosphate and Odam's Chemical Manure Company, Limited), 116, Fenchurch-street, E.C.; E. W. Pontifex (Pontifex and Wood), Shoe-lane, E.C.; Price's Patent Candle Company, Limited, 31, Threadneedle-street, E.C.; G. Atkinson (Atkinson, George, and Co.), 66, Aldersgate-street, E.C.

3. *Chemical Merchants' and Brokers' Sub-section.*

G. M. Bauer, 59, Mark-lane, E.C.; George Bennett (Bennett, George, & Sons), 10 & 11, Mincing-lane, E.C.; W. G. Blagden (Blagden & Angus), 1, Fenchurch-avenue, E.C.; W. Caudery (Caudery, William, & Co.), 150 & 151, Fenchurch-street, E.C.; D. W. Greenhough, 9, Mincing-lane, E.C.; L. P. Fielder (Pokorny, Fielder, & Co.), 15, Fish-street-hill, E.C.; G. J. Saunders, (W. C. Bacon) 14, Mincing-lane, E.C.; W. Tennant (Tennant, Charles, Son, and Co.), 9, Mincing-lane, E.C.

4. *Drysalters and Druggists' Sub-section.*

A. Preston; — Umney; John Moss; J. Skilbeck; Barron, Squire, and Co.; Burgoyne, Burbidges, and Co.

NOTICES OF BOOKS.

Life of Sir William E. Logan, Kt., LL.D., F.R.S., F.G.S., &c., First Director of the Geological Survey of Canada. Chiefly compiled from his Letters, Journals, and Reports. By BERNARD J. HARRINGTON, B.A., Ph. D., Professor of Mining in M'Gill University; late Chemist and Mineralogist to the Geological Survey of Canada. London: Sampson Low, Marston, Searle, and Rivington.

BEFORE us lies the record of a career in some respects probably unique. We have here a man certainly not educated for scientific pursuits, and spending his days up to the age of thirty-three in the counting-house of a London merchant. Yet, from the firm with which he is connected, having entered into speculations connected with copper-mining, we find him, as if touched by the wand o a fa ry, transformed into an efficient metallurgist and miner, and a real y eminent geologist. In one sense, therefore, his life may prove a bad lesson, as supporting the common delusion that a man may, if he needs it, "pick up" any branch of science at any time. If Logan succeeded by dint of a rare capacity, bodily and mental, for hard work, hundreds would, under similar c rcumstances, have failed completely. Nor is it difficult to perceive that if he had enjoyed a good chemical education the undertaking would have been more remunerative. One part, namely, of the speculation consisted in a patent for extracting copper from slags, which were to be worked over again. This process came to nothing, so that the capital sunk in the purchase of the invention, and of some millions of tons of old slags, was to a great extent sacrificed. But that part of the business which consisted in smelting copper according to the ordinary Welsh process and in coal-mining, proved successful. From getting coal, as we are told, he was led to examine the origin of this mineral and to study the structure of the Glamorgan coal fields. So indefatigably did he work that by the time he had resided two years at Swansea, and whilst attending most diligently to business, he had completed a geological map of the district which was adapted by Sir H. de la Beche for the Government Survey with high encomiums. His first great geological discovery was the demonstration that the coal-beds had been formed in *situ* and were not accumulations of drift wood, &c. He came to this conclusion from observing the invariable presence, under each seam of coal, of a bed called by the local miners the "under clay." In these beds were found the remains of certain trees, then known as *Stigmariæ*, since proved to be roots of *Sigillariæ*, and in such positions that they must evidently have grown on the spot. In 1837 he was elected a Fellow of the Geological Society, before which he read an account of his observations on the coal-beds. He took an active part in the management of the Royal Institution of South Wales, in which he filled the office of Geological Orator. When he left Wales and returned to Canada, his native country, he had already become widely and favourably know to the leading geologists of the day as an earnest and accurate worker. In 1842 the project of geological survey of Canada, which had been frequently brought forward, was at last carried into execution, and on the earnest recommendations of De la Beche, Sedgwick, Murchison, and others, Logan was appointed the Director. Though now in his forty-fourth year he entered at once upon this vast undertaking, and often with but scanty appliances he conducted it successfully till, in his seventy-second year, his failing strength compelled him to resign, to the universal regret of the Colonial Government and of the Canadian public. It is impossible for us in our narrow limits to given even a sketch of his investigations and of their results. He was evidently a stratigraphist, little given to theorising and not much versed in palæontology, or in mineralogy and chemistry, in which latter departments, after being annoyed by some incompetent assistants, he had the insight to secure the services of Dr. T. Sterry Hunt. His practical experience in mining and metallurgy often enabled him to assist all who were engaged in *bona fide* attempts to develope the mineral wealth of Canada, and, on the other hand, to expose those impostors who merely sought to prey upon the public. He was not unfrequently urged to give his opinion upon auriferous quartz. "On one occasion a number o specimens were shown to him by some speculators in the presence of intending purchasers of the property. Sir William's opinion was asked whether the glittering metal visible at the bottom of the little cavities in the quartz was really gold. 'No doubt of it,' said the unmoved critic, after eying it closely with a pocket magnifier. 'No doubt of it, and with this glass you can see the marks of the punch perfectly.' On another occasion he was pressed for an answer to the question whether there was not an enormous quantity of copper within an area described. He satisfied both the intending seller and the contemplating purchaser by the reply, "There is an enormous quantity of copper—an enormous quantity; and it is my opinion that it will cost just a little more than it is worth to get it out.'"

Unlike the majority of modern biographies this work must be pronounced an interesting and well-written history of an honourable and useful life.

Elementary Treatise on Physics, Experimental and Applied for the Use of Colleges and Schools. Translated and edited from Ganot's "Elements de Physique" (with the author's sanction), by E. ATKINSON, Ph.D., F.C.S., Professor of Experimental Science, Staff College, Sandhurst. Eleventh Edition, revised and enlarged. London: Longmans, Green, &c.

GANOT'S Physics, in Dr. Atkinson's version, is so well established in public favour in this country that no discussion of its merits and no exposition of its leading features can be needed. The present edition is enriched with thirty-two pages of additional matter, and with thirty more illustrations. Among the alterations we note the account of the endosmose of gases, their effusion and transpiration, absorption and occlusion has been transferred to Book IV., chap. 2nd, whilst in its former place, Book III., chap. 3, stands the description of hydraulic tourniquets, turbines, &c. This transposition is a decided improvement. A notice of Twaddell's hydrometer, which is wanting in the original as well as in the previous English editions, is

now inserted, though its superiority over Beaumé's instrument is not explained. The statement that dilute alcohol becomes more concentrated if kept in a bladder, though it has for a long time passed current in text-books, is not in harmony with the most recent researches.

In Book V., treating on sound, we find no alteration calling for notice.

In Book VI., there is an account of Jolly's method for determining the expansion of gases. In treating of the formation of vapour in closed tubes the Editor gives a more complete explanation of the critical point than was found in the last edition, and he also adds a definition of vapour as "a gas at any temperature below its critical point." Hofmann's method for the determination of vapour-densities is inserted, and a paragraph is added on the relation of vapour-density to molecular weight and on dissociation.

The chapter on the steam-engine has been re-written.

In the book on Light we find a notice of Professor Rowland's results on diffraction-spectra.

The most numerous additions and alterations, however, are to be found in the books dealing with Magnetism and Electricity. Thus we have additional matter on the Holtz machine, a more detail account of residual charges, a description of the bichromate battery, and of Niaudet's element, and of Incandescent lamps. The secondary batteries of Planté and Faure are figured and described at length. Matteucci's laws of induced currents, as found in the last edition, are omitted, but we have figures and descriptions of Pacinotti's ring and of the Brush dynamo-electrical machine. The chapter on the determination of electric constants has been greatly extended and improved. In short the work has been, as a whole, carefully brought up to the level of the most recent investigations.

The Retrospect of Medicine, being a Half-yearly Journal, containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxvii., Jan.—June, 1883. London: Simpkin and Marshall.

Comparatively little of the matter contained in this volume has a chemical interest. Dr. J. Murray Gibbes, of New Zealand, speaks favourably of the *Eucalyptus globulus* as a disinfectant. Dr. J. Cossar Ewart gives a partial explanation of the "milk epidemic" at Aberdeen. The milk suspected and the pus obtained, from abcesses in the patients, contained virulent tacilli. These, it appears, had been added to the milk along with water. The water used at the dairy previously to the epidemic passed through a large concrete cistern (fitted with a loose, rough wooden cover) fixed in the corner of the large cow-house immediately over the heads of the cows. The spores arrived along with the steamed hay used for food, and had thus ready access to the cistern. How they reached the tank in which the hay was steamed is unexplained.

Dr. F. J. B. Quinlan upholds filtration through spongy iron as a sure means of destroying disease germs—a conclusion which the eminent microscopist, Mr. Jabez Hogg, does not accept.

Dr. A. D. Macdonald is in favour of ammonium benzoate as a germ destroyer.

Dr. Oliver proposes certain test-papers for the detection of albumen in urine. The papers are prepared either with potassium ferrocyanide, potassium mercuric iodide, &c. As these reagents are inoperative except in strongly acidified urine, a slip of paper, saturated with citric acid, is added to the sample in a small test-tube, either along with or prior to the ferrocyanide papers. Dr. F. W. Pavy makes up potassium ferrocyanide and citric acid into small pellets, which he uses for the same purpose.

The papers "On our Present Knowledge of Fever," by Dr. W. Moxon, on the "Germ Origin of Disease," by Dr. Quinlan, and "A New Fact in the Pathology of Parasitic Organisms," by the Editor of the *Medical Times*, though of great scientific interest, scarcely come within our legitimate scope. We fear Dr. Quinlan will fall under the ban of the Vegetarians for showing that herbivorous animals are more liable to phthisis than the carnivorae.

Vichy and its Therapeutical Resources. By Prosser James, M.D., M.R.C.P. London: Baillière, Tindall, and Cox; Alexander and Shepheard.

Vichy appears to be a gathering place of a number of different kinds of mineral waters, recommended in a variety of diseases and at present eagerly and hopefully quaffed by those who, having lived as they please, now suffer what they must. The principal ingredient in these springs, and the one to which their medicinal value is chiefly ascribed, is sodium bicarbonate. Corresponding salts of potassium, magnesium, and calcium are also present, but in much smaller quantities, and are, by the author, considered of little consequence in a medicinal point of view. Phosphates and arseniates are present in small quantities. The analysis of Bouquet here quoted make no mention of metallic sulphides or of sulphuretted hydrogen, the odour of which is distinctly recognised in the water of the "Park" spring. Prof. Tichborne, in his "Mineral Waters of Europe," detects traces of lithium chloride, on which Bouquet is silent.

The medical uses of the various springs and their supposed *modus operandi* are not fit subjects for our discussion.

CORRESPONDENCE.

FAST-RED OR ROCELLIN.

To the Editor of the Chemical News.

Sir,—After reading the report on the legal decision on the Badische Anilin and Soda Fabrik *versus* Levenstein, I find the expert made three sulphonations of α-naphthylamine, one with 80 per cent, one with 30 per cent, and one with 10 per cent of active sulphuric acid anhydride. According to chemical literature, naphthylamine can also be easily sulphonated with ordinary concentrated sulphuric acid; but in the Specification of the Patent, No. 786, 1878, this method is not described, or an example given, to produce the naphthylamine-sulphonic acids by the direct action of ordinary concentrated sulphuric acid, and therefore the case *adhuc sub judice lis est.*—I am, &c.,

Aequum et Bonum.

PRIESTLEY AND LAVOISIER.

To the Editor of the Chemical News.

Sir,—It is certainly strange to see Mr. G. F. Rodwell—who formerly defended, in the Chemical News, Priestley's discovery of oxygen against the pretences set up in favour of Swedenborg—disparaging in a French review the great Englishman's greatest discovery, under cover of defending the absurd claims set up by and for Lavoisier.

I trust your sense of impartiality will permit me to briefly point out in your wide-spreading columns, with reference to Mr. Rodwell's article in the *Revue Scientifique*, (1) That, taken in connection with Priestley's own account, published in 800, Lavoisier's statement—"This air which MM. Priestley, Scheele, *and myself* discovered almost simultaneously"—most certainly *does* prove "that he laid a dishonest claim to the discovery of oxygen." Priestley's account is this—"Having made the discovery (of oxygen) some time before I was in Paris in the year 1774, *I mentioned it at the table of M. Lavoisier*, when most of the philosophical people in the city were present, saying it was

a kind of air in which a candle burned much better than in common air, but I had not then given it any name. At this all the company, and M. and Madame Lavoisier *as much as any*, expressed great surprise. I told them I had gotten it from precipitate *per se*; also from red lead; but Mr. Scheele's discovery was certainly independent of mine."

(2.) Lavoisier's name for the gas, "oxygen" (or acid generator), although now universally adopted, is well known to be founded upon a quite erroneous apprehension, and shows that he completely misunderstood the nature and capabilities of the gas he says he discovered; whilst, on the other hand, if Mr. Rodwell possessed or had access to any edition of Priestley's works, he would never have made such a totally incorrect and unwarranted statement as that attributing the supposition to the English philosopher that his discovery was "ordinary air containing nitrous corpuscules."

(3.) Candid philosophers, such as Dr. T. Thomson, writing at, or not long after, the time the events occurred, were much more likely to have hit the truth and to have formed a correct judgment than we can possibly be now, and throughout Europe (except in France) Lavoisier's "claims" in this respect are ignored. At the laboratories in Bonn and Heidelberg lately I saw busts of Priestley and Davy, but none of Lavoisier.—I am, &c.,

W. A. Ross.

Acton, W., July 29, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 3, July 16, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Brief Description of an Electric Counter.—J. Cauderay.—This instrument cannot be intelligibly described without the accompanying figure.

A New Theorem of Dynamic Electricity.—L. Thévenin.—A mathematical paper, incapable of useful abstraction.

Emersion Currents, and the Movement of a Metal in a Liquid and the Emersion Currents.—M. Krouchkoll.—If two electrodes of one and the same metal be plunged into a liquid, it is known that if one of them is moved within the liquid, there arises a current, the direction of which varies with the nature of the metal and of the liquid in contact. It is also known that if one of the electrodes is already placed in a liquid and the other is plunged in also, there is produced a current at the moment of immersion. The author finds that an electric effect of the same kind is obtained when one of the electrodes is withdrawn from the liquid: there is then produced a feeble emersion current. He announces a simple relation between these three kinds of current: The current produced by immersion is contrary in direction to that produced by movement; the emersion current has the same direction as the movement current.

New Oxide of Copper Battery.—F. de Lalande and G. Chaperon.—This battery is based upon the simultaneous use of copper oxide, caustic potassa, and zinc. In order to form with copper oxide depolarising electrodes, it is merely requisite to keep it in contact with a plate, or a vessel of iron or copper, forming the positive pole of the element. These elements may be made so as to have a great surface by using vessels of wrought- or cast-iron, which are not attacked by the exciting liquid. The amalgamated zinc and the copper oxide are not acted upon by the alkaline solution. The battery is therefore constant. Its electromotive force is nearly 1 volt, and its internal resistance is very slight.

Density of Liquid Oxygen.—S. Wroblewski.—The most probable value is 0·895.

Salts of Aurous Oxide. Colorimetric Determination of Gold.—A. Carnot.—The author employs a solution of hydrogen phosphide, obtained by decomposing calcium phosphide with hydrochloric acid and receiving the gas in pure water. If this liquid is poured gradually into a very dilute solution of gold chloride, either pure or containing phosphoric or arsenic acid, there appears in it a fine rose colour. This colouration is therefore due not only to a complex salt of aurous and ferric oxides, but also to simple aurous salts. The presence of ferric oxide merely gives these salts greater stability. As regards the use of this reaction in the quantitative determination of gold, the author finds that if we employ progressively increasing proportions of gold (*e.g.*, 0, 1, 2, 3, . . . 9, 10 tenths of a milligrm.), and a constant volume of liquid (100 c.c.) the rose colouration becomes deeper and deeper. A scale of tints may thus be established. The degrees are very distinct up to 1 milligrm.; above this point the colouration is too intense, so that it is necessary to operate on more dilute solutions. The liquid to be examined is treated in the same manner and in a similar phial, and compared with the former series in the manner usual in colorimetry. The simplest method of obtaining coloured solutions for comparison is the following:—Add to the neutral solution of gold chloride a drop of hydrochloric acid, one or two drops of solution of ferric chloride, and a few drops of arsenic acid diluted with water to 100 c.c.; add a small pinch of zinc powder, and shake up; let settle, and pour off the clear. In case of a gold ore which it is required to value rapidly, the author takes 10 to 30 grms. in fine powder; treats with *aqua regia*, dilutes, and filters to get rid of the gangue; evaporates to dryness, evaporates a second time with a little nitric acid, and heats to dull redness. The residue is treated with chlorine water, which dissolves the gold without attacking the ignited ferric oxide. After expulsion of the chlorine the liquid is ready for the colorimetric assay. The other metals most frequently present in gold ores, such as antimony, copper, zinc, &c., do not interfere with this process. The author recommends it, not as a substitute for the dry assay, but as a rapid and approximate method.

Alcoholate of Baryta.—M. de Forcrand.—The author has determined the heat liberated in the formation of this compound by the action of anhydrous baryta upon absolute alcohol.

Action of Aldehyd upon Propyl-glycol.—Arnaud de Gramont.—The author heats together equal weights of aldehyd and iso-propyl-glycol to 160° in a sealed tube, and obtains a new compound, probably propylen-acetal, $C_5H_{10}O_2$.

Researches on Cinchonamine.—M. Arnaud.—The author has examined the hydrochlorate, hydrobromate, hydriodate, nitrate, sulphate, formiate, acetate, oxalate, tartrate, malate, and citrate of this base.

A New Glycerin.—The compound in question is the mesitylenic glycerin, $C_6H_3(CH_2.OH)_3$.

On Heating with Coal, with Conversion of its Nitrogen into Ammonia.—M. Scheurer-Kestner.—The author contends that the heat lost in the conversion of coal into coke and coal-gas (= 19·3, or nearly 20 per cent) outweighs the value of the ammonia produced, except when coal is very cheap. According to the results of Mr. Foster, which he quotes from the *Journal of the Chemical Society*, only 14·5 per cent of the nitrogen present in the coal is converted into ammonia, and 1·5 as cyanogen, the remainder either escaping as free nitrogen or remaining in the coke.

Journal für Praktische Chemie.
New Series, Vol. xxvii., Parts 10 and 11.

Contributions to the Chemistry of the Rhodium-ammonium Compounds.—S. M. Jörgensen.—A detailed account of the chloro-purpureo-rhodium chloride, nitrate, silico-fluoride, platinum-chloride, sulphate, and carbonate; the bromo-purpureo-rhodium bromide, nitrate, silico-fluoride, and platinum-bromide; the iodo-purpureo-rhodium iodide, the iodo-purpureo-rhodium chloride, nitrate, silico-fluoride, platinum-iodide, and sulphate; and the dichloro-tetra-pyridin-rhodium chloride. The author then describes some preliminary experiments on the determination of the atomic weight of rhodium, for which purpose he considers the chloro-purpureo-rhodium chloride and the corresponding bromine compound, on account of their great permanence. His experiments have given the values 103·18 and 103·05, but his researches on this subject are being continued.

What is Isatine?—H. Kolbe.—The author regards isatine as nitro-benzoyl-formyl, *i.e.*, a compound of formyl with benzoyl, in the latter of which an atom of monovalent nitrogen is substituted for one of the atoms of hydrogen. Prof. von Meyer, on the other hand, regards isatine as benzoyl-nitro-carbinol—

$$\left(CO.C_6\begin{Bmatrix}H_4\\n\end{Bmatrix}\right)'.n_2.COH.$$

Preparation of Symmetric Diphenyl-urea and Diphenyl-guanidine.—W. Hentschel.—On distilling a mixture of phenol sodium and ethyl-oxide carbanilate in proportions corresponding to their molecular weights, pure phenetol passes over at about 220°; the operation is best conducted in a current of hydrogen. The residual cake is repeatedly boiled with water, when sodium carbonate dissolves and diphenyl-urea remains in fine prisms, which are purified by re crystallisation from hot alcohol. Pure diphenyl-urea is ground up with its equivalent of sodium ethylate, and heated to 220° in a current of hydrogen, when a clear oily distillate passes over, which proves to be pure aniline. The contents of the retort are dissolved in hot dilute hydrochloric acid. The solution is filtered, and a little fuming hydrochloric acid is added to the filtrate while still hot. On cooling the liquid congeals to a thick paste of yellow or grey crystals, which after re-crystallisation prove to be triphenyl-guanidine hydrochlorate.

Thymol Derivatives.—A. K. Richter.—We have here an account of ethyl-thymyl carbonate, dithymyl carbonate, the behaviour of sodium-phenylate and alcoholate with ethyl-thymyl carbonate, and the behaviour of the alkali-alcoholates with dithymyl carbonate.

Preparation of Acetamide and some other Amides of the Fatty Series.—Julius Schulze.—The author digests 1 mol. ammonium sulpho cyanide with 2½ mols. glacial acetic acid for three to four days. The yield does not fall far short of the theoretical quantity.

Preparation of Ammonium Sulpho-cyanide.—Julius Schulze.—The author gives, as the best proportions, 600 grms. alcohol at 95 per cent, 800 grms. ammonia at 0·912 sp. gr., to from 350 to 400 grms. carbon disulphide. Larger proportions of alcohol and ammonia do not increase the yield.

Novel Formation of Anthracene.—O. Henzold.—The author heats a mixture of benzyl-ethylether and phosphoric anhydride in a vessel fitted with a reflux condenser. When the violent reaction is over, he heats more strongly, and distils the product. The semi-solid distillate is freed by imbition from undecomposed benzylic ether, and from an oil, the nature of which is not yet known. It is then repeatedly re-crystallised from glacial acetic acid, and finally purified by cautious sublimation. The product thus obtained is physically and chemically identical with pure anthracene from coal-tar.

Bulletin de la Société Chimique de Paris.
No. 1, July 5, 1883.

Researches on the Electrolysis of Sodium Chloride.—Laurent Naudin and A. Bidet.—The authors have undertaken their researches with a view to the application of the chlorine in bleaching. They set out with the supposition that with an apparatus suitably arranged it should be possible to recover and use over again almost the totality of the chlorine, which, except the losses incurred in washing the goods after bleaching, may thus serve indefinitely. After a prolonged course of experiments they conclude that this rotation of chlorine is possible with an apparatus properly arranged, and with a small electrolytic force. The mode of action of the current has a considerable influence upon the yield of total active chlorine. In certain cases this increase may extend to six-fold with the same electromotive force.

Certain Double Salts of Lead.—A study of the lead oxy-chlorides and oxy-bromides.

Azotometry in Ammoniacal Manures.—Wareg Massalski.—This important memoir cannot be reproduced without the accompanying illustration.

Russian Chemical Society.—Session November 4/16, 1882.—M. Poehl announces that almost all animal and vegetable tissues possess the property of transforming albumenoid matters into peptone.

M. Elkétoff sent in a communication on certain oxides of the series $C_n H_{2n}O$, most of which have not yet been studied.

M. Basaroff submitted a study on the oxidation of sulphur distributed on vines. The air above the vines thus treated contained sulphurous acid in the proportion of 0·004 per cent by volume, or 0 0 9 per cent by weight.

M. Orlowsky sent in analyses of the mineral waters of Slawinsk, which contain a large proportion of ferrous salts.

The same chemist communicates a note on the use of sodium hyposulphite in qualitative analysis in place of hydrogen sulphide.

M. Orloff has studied the hydrogenation of the essential oil of turpentine and of cymene.

MM. Markownikoff and Oglobine, by the action of chlorine upon the hydrocarbons $C_n H_{2n}$, occurring in the petroleum of the Caucasus, have obtained chlorinated compounds, $C_n H_{2n-1}Cl$.

M. Gustawson sent in papers on the cause of the effect produced by minimal quantities of aluminium chloride and bromide on the conditions of the transformation of normal propyl into iso-propyl.

M. Alexeeff described the results of his thermic researches on the aqueous solutions of salicylic acid.

At the Session December 2/14, 1882, M. Konovaloff described his experiments on pyro-sulphuryl chloride (see *Comptes Rendus*, xv., p. 1284).

M. Sokoloff gave results of analyses of air obtained by means of his new eudiometer.

M. Almedingen communicated novel facts relative to the transformation of crotonylene into a hydrocarbon corresponding in its properties to hexa-methyl-benzine.

M. Poehl has studied the putrefaction of flour, and the action of ergot upon the latter in order to detect the origin of the disease known as raphanie. This disease springs, according to the author, from the use as food of decomposing flour containing ergot. The injurious action of such flour is due to the ptomaines formed on the decomposition of the peptones derived from the albumenoid matter of the flour. As ergot possesses, according to the experiments of the author, the property of transforming albumenoid matters, it contributes indirectly to the formation of ptomaines in the flour.

M. Mendelejeff announces that the hydrocarbons of petroleum boiling between 30° and 40°, have, at +18°, a specific gravity of from 0·625 to 0·637, *i.e.*, the same as the hydrocarbons of Pennsylvanian petroleum having the same boiling-points. This fact is the more remark-

able as the hydrocarbons of American petroleum boiling above 40°, are less dense than the hydrocarbons of Baku, having the same boiling-point.

M. Mendelejeff also explained his ideas on the structure of benzol, and communicated his researches on the method of preparing a lighting oil, which may be used in lamps w thout danger.

MM. Beilstein and Kourbatoff communicate the results of their researches on the petroleum of the Caucasus. The petroleum of Baku contains chiefly hydrocarbons of the series $C_n H_{2n}$, identical with the products of the hydrogenation of the aromatic hydrocarbides, $C_n H_{2n-6}$. The petroleum of the so-called "Royal Wells" is composed principally of hydrocarbons $C_n H_{2n+2}$, with which are mixed hydrocarbons $C_n H_{2n-6}$; it contains also a very little of hydrocarbons $C_n H_{2n}$. American petroleum contains hydrocarbons $C_n H_{2n+2}$ and $C_n H_{2n-6}$, and a very small quantity of $C_n H_{2n}$. It contains also abundance of solid hydrocarbons (paraffins) not found in Russian petroleum. The lighting oil obtained from the petroleum of Baku has a higher specific gravity than that from American petroleum; it burns with a much brighter light, and contains hydrocarbons sensibly richer in carbon.

No. 2, July 20, 1883.

Note on the Crystallisation of Bodies at High Pressures.—MM. E. Jannettaz, Neel, and Clermont.—M. Friedel, having contested the announcement of M. Spring that a pressure of 5000 atmospheres exerted upon amorphous pulverulent matters causes them to become aggregated into crystalline masses, the authors determined to repeat his experiments, using pressures of from 6000 to 8000 atmospheres. They operated upon pulverised antimony, bismuth, zinc, iron, tin, copper, and lead; Darcet's alloy and brass, lead, and zinc sulphides, sodium lead and mercurous chlorides, mercuric iodide, magnesia, alumina, silica, chalk, and copper sulphate. All these powders were agglutinated into solid masses, but even those which acquired some degree of transparency were not crystallised. Many of the substances, however, such as steatite, graphite, clays, and metals, acquired a schistous structure, and assumed the thermic properties characteristic of such structure.

Thermic Study of the Solution of Hydrofluoric Acid in Water.—M Guntz.—The author has determined the solution-heat of hydrofluoric acid in the gaseous and the liquid state, and the heat of this acid in different states of concentration.

Decomposition of Certain Organic Bodies by the Effluve.—M. Maquenne.—The bodies experimented upon are ethylic and metylic alcohols, acetic acid, acetone, and methyl formiate. It seems permissible to conclude that the effluve acts in a manner quite similar to heat alone.

Presence of Mannite in the Pineapple.—L. Lindet.—In addition to 8·2 per cent of saccharose and 2·6 of reducing sugars, the author finds 1 per cent of mannite, calculated for the weight of the fresh fruit.

Observations on Duplo-thiacetone.—W. Spring.—The author studies the preparation of duplo-thiacetone and the formation of oxy-thiacetone; the behaviour of the former body with nascent hydrogen, the oxidation-products of oxy-thiacetone and of the accompanying bodies, and their behaviour with chlorine.

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Applications, with *copies* of testimonials, to be sent on or before September 1, 1883, to the Warden, from whom further particulars may be obtained. MUNRO SCOTT, Warden.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

22, ALBEMARLE STREET, LONDON, W.

The next ANNUAL GENERAL MEETING will be held at SOUTHPORT, commencing on WEDNESDAY, September 19.

President-Elect:—

ARTHUR CAYLEY, Esq., M.A., LL.D., F.R.S., V.P.R.A.S., Sadlerian Professor of Mathematics in the University of Cambridge.

NOTICE TO CONTRIBUTORS OF MEMOIRS.—Authors are reminded that, under an arrangement dating from 1871, the acceptance of Memoirs, and the days on which they are to be read, are now, as far as possible, determined by Organising Committees for the several Sections *before the beginning of the Meeting*. It has therefore become necessary, in order to give an opportunity to the Committees of doing justice to the several Communications, that each Author should prepare beforehand an Abstract of his Memoir, of a length suitable for insertion in the published Transactions of the Association, and the Council request that he will send it, together with the original Memoir, by book-post, on or before August 22, addressed thus:—"General Secretaries, British Association, 22, Albemarle Street, London, W. For Section . . . . . ." Authors who comply with this request, and whose Papers are accepted, will be furnished *before* the Meeting with printed copies of their Reports or Abstracts. If it should be inconvenient to the Author that his Paper should be read on any particular days, he is requested to send information thereof to the Secretaries in a separate note.

T. G. BONNEY, Secretary.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accouchership; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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The WINTER SESSION will open on MONDAY, OCTOBER 1, with an Introductory Address by Dr. HANDFIELD JONES, F.R.S., Senior Physician to the Hospital. The Chair at the Annual Dinner in the Evening, at Limmer's Hotel, George Street, Hanover Square, will be taken by Spencer Smith, Esq., F.R.C.S., Consulting Surgeon to the Hospital.

Four Open Scholarships in Natural Science, each of the value of £50, will be offered for competition on October 2 and following days.

The School buildings, to which large additions have been made, especially as regards the laboratories for the teaching of Physiology and Chemistry, will be ready for occupation on October 1; and it is intended to open on the same day a "Student's Club and Refreshment Room," for the convenience of the Pupils of the Hospital, in the building itself.

In addition to the open Entrance Scholarships, Class Prizes, and usual Appointments, Scholarships will be offered for competition at the end of each year, open to all pupils of the Hospital. These Scholarships are of the value of £20, £25, and £30, for the first, second, and third years respectively.

Further information may be obtained of the Dean, or of the Medical Superintendent at the Hospital.

A. B. SHEPHERD, M.D., Dean of the School.

29th June, 1883.

LEEDS MECHANICS' INSTITUTION and LITERARY SOCIETY.—Wanted, from the 10th September next, a SCIENCE MASTER for the Day and Evening Classes in connection with the above Institution. He will be required to teach Theoretical and Practical Inorganic and Organic Chemistry and Metallurgy. Previous practical training in chemical analysis indispensable. Fixed salary £200 per annum, with share of results, which during the past two years have produced for the Teacher an average of £100 per annum.—Applications, with full particulars and testimonials (not more than three in number), to be addressed to the Secretary, Cookridge Street, Leeds, not later than Saturday, August 11th.

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Dated 16th July, 1883.

(Signed) J. HENRY JOHNSON,
47, Lincoln's Inn Fields, London,
Solicitor for the said Company.

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AND

JOURNAL OF PHYSICAL SCIENCE.

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A 20-horse Water Motor, pumping for H. Vivian, Esq., M.P.

A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

June 22, 1881.—From H. H. Vivian, Esq., M.P.—"I have just heard that the Water Motor sent out last year is doing well."

Lord Salisbury's Clerk of Works writes:—"I am much pleased with the Water Motor, for it is most compact and useful."

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1237.

PEMBERTON'S METHOD FOR THE VOLUMETRIC ESTIMATION OF PHOSPHORIC ACID.*

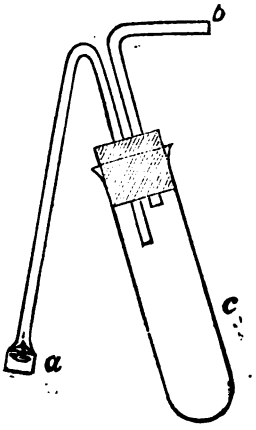
By Prof. G. C. CALDWELL.

Mr. H. Pemberton, Jr., has described (*Journal Franklin Institute*, March, 1882, p. 184), a new method for the volumetric determination of phosphoric acid, especially in fertilisers, by a standard solution of ammonium molybdate; he adds the precipitant to the suitably prepared solution of the fertilisers as long as a precipitate is produced, the final tests for further precipitation being made with small filtered portions of the solution under examination. He prepares his standard solution by dissolving 89·543 grms. of ordinary ammonium molybdate in 1000 c.c. of water; each cubic centimetre of such a solution precipitates 3 milligrms. of phosphoric anhydride. The solution of the phosphate is freed from silica and organic matter, then made up with as little excess of acid as possible, and just neutralised with ammonia; 2 c.c. of nitric acid (sp. gr. at least 1·4) and 10 grms. of ammonium nitrate are added, and the solution is heated to 60° C., or above, preparatory to adding the molybdate; it is necessary to apply the filtration test only towards the end of the operation, when it becomes difficult to discern the effect of further addition of the molybdate, even in the supernatant liquid that has been somewhat clarified by standing for a minute or two.

The frequent need of the determination of phosphoric acid in fertilisers, the absence of any thoroughly reliable volumetric method for this determination, and the length of time required for the gravimetric method, when the acid must first be precipitated by molybdate, all unite to give special interest to such a method as this, in which the molybdate itself, giving so sharp a reaction for the acid, is used directly in the standard solution.

With one modification in the preparation of the standard solution, and another and more important one in the mode of filtering out the test-portions, the process has satisfactorily sustained a series of careful tests in the laboratory of the University. As to the preparation of the standard solution, Pemberton found that the ordinary ammonium molybdate of the druggists was sufficiently pure to give the standard directly; in order to clear away the slight turbidity which the salt usually leaves he added a little ammonium hydrate. It was observed by Dr. Newbury, then analyst to the Station, that in the case of the molybdate supplied to us, a notable degree of alkalinity was communicated to the solution by the quantity of ammonium hydrate required to clarify it, and that, consequently, the necessary acidity produced by the nitric acid added in the beginning to the solution of the phosphate, became so much reduced towards the end of the titration after a considerable quantity of the molybdate had been added, that the results were unsatisfactory; in some instances the solution even became slightly alkaline before the precipitation was completed. In order to avoid this difficulty the molybdate solution was filtered after the addition of a few drops of ammonia at the most, and then standardised by a solution of phosphorus salt in which the phosphoric acid had been carefully determined by molybdate and magnesia mixture in the usual manner.

As to the manner of taking out the final test-portions, even when this operation is performed as described by Mr. Pemberton, this method of determining phosphoric acid is unquestionably more expeditious than the usual precipitation method; but the necessity of filtering out each test-portion in the ordinary way through a filter has its evident objections. For this filtration we have used in this laboratory with entire success a little contrivance that was applied with like success some years since in the determination of sulphuric acid by a standard solution of barium chloride, in a modification of Wildenstein's method as described by Fresenius. The apparatus, as still further improved, more recently, is shown in the adjoining figure. The internal diameters of the bent tubes *a* and *b* should be about one millimetre, and that of the mouth at *a* about five millimetres. The length of the arm *a* may of course be adapted to the depth of the beaker used. To prepare the filter for use a small perforated platinum cone, or a tangle of fine platinum wire, is crowded into the throat of *a* so that it will not fall out when the mouth of the tube is downwards; suction is applied at *b* by a rubber tube to



the mouth or connected with the exhaust; *a* is dipped for an instant only in a very thin asbestos pulp, and the suction is continued while the filter is then plunged into water and till the wash water comes through clear; it is then ready for use.

In using it, the only precaution to be observed, and that is an essential one, is never to plunge the filter into a liquid unless suction is applied to it, and to continue the suction as long as it remains in the liquid; otherwise the asbestos and cone may fall out of the tube. The filter being thus withdrawn, the liquid contained in it and the tube *a* is drawn over into the test-tube; two or three drops of the molybdate solution are run directly into *c* to test for complete precipitation, the rubber cork and its two tubes being meanwhile conveniently hung on a hooked wire attached to the lamp stand; the test being completed by heating the contents of the test-tube just up to boiling, the liquid is poured back into the beaker and the tube is rinsed also into the beaker with a very little hot water; when the next test-portion is to be filtered out the first filtrate drawn over is poured back into the beaker, thus using this portion to wash out of the filter and tube the last portions of liquid adhering to it from the previous filtration. The final reaction is so sharp that, towards the end of the titration, we have found it sufficient to add to the solution in the beaker only the few drops of molybdate added to the test-portion.

In the following table the results are given of our tests of this method of determining phosphoric acid. The solutions of the phosphate analysed and of the molybdate were prepared by Dr. Newbury, and the gravimetric determinations by the ordinary molybdate method were also made by him. The several volumetric tests following were made, using these solutions, by Dr Newbury (I.), Dr.

* *Journal of the Franklin Institute*, July, 1883. From advance sheets of the Second Report of the Cornell University Experiment Station.

Station. Number.	I. Grav.	I. Vol.	II. Vol.	III. Vol.	IV. Vol.
235		13·14	13·27	—	13·13
		13·14	—	—	13·18
					13·15
					13·12
259	12·47	12·33	12·39	12·44	12·34
	12·41	12·33	—	12·45	
				12·47	
261	9·15	9·26	9·08	9·20	9·34
	9·21	9·26	—	9·05	9·37
				8·97	
				8·97	
272	13·69	13·57	13·75	13 82	
	13·82	13·57	—	13·81	
		13·69	—	13·72	
		13·69			
		13·63			

S. M. Babcock (II.), then instructor in the chemical department, and myself (III.), and in every case in entire ignorance of the results obtained by the others. Mr. Furry (IV.), at present the analyst of the station, prepared his own solutions throughout.

Most of these results speak well in favour of the method, and it appears to be capable of greater accuracy than is here indicated; for in most cases, and apparently in accordance with Mr. Pemberton's directions, larger quantities of the molybdate were added between each test towards the close of the titration than were necessary; these additions should be made by 0·1 c.c. at the most. But the results obtained in the case of No. 261 do not agree closely enough hardly even for technical work; there seemed to be some source of error there which may be revealed by a further examination of the phosphate.*

I am permitted by Dr. S. M. Babcock, now chemist of New York State Experiment Station, to mention in this connection his good success in determining reverted acid by precipitation with magnesia mixture from the ammonium citrate solution, according to Johnson's method, solution of the precipitate in nitric acid, and titration with standard molybdate.

[The yellow phospho-molybdate has frequently been used as a basis of calculation in determining *small* quantities of phosphorus in analyses of iron and its ores. But never, to my knowledge, has it heretofore been successfully employed where large percentages of P_2O_5 were to be determined. Previous to the investigations of Dr. Gibbs, on the phospho-molybdates, many chemists were in doubt as to whether the yellow precipitate, with its extraordinary formula, actually was a definite chemical compound or not. Different analyses of it varied as much as 30 per cent on the total P_2O_5 contained therein. Eggertz and Finkner showed how the precipitate could be formed so as to vary in per cent P_2O_5 within moderate limits, and the phosphorus estimations in iron and steel were thereupon based upon the direct weighing of the yellow salt.

It appears to be an impossibility, however, to precipitate the pure yellow salt, with the ratio of MoO_3 to P_2O_5 *exactly* as 24 : 1, when the usual nitric acid solution of the molybdate is employed. Because the length of time during which the solution must stand in the heat, and the large excess of the precipitant required, cause more or less MoO_3 to fall with the precipitate.

It is very evident, therefore, if there is any tendency in the same direction when the *aqueous* molybdate solution is employed, that the volumetric process would be unreliable, and the error a radical one. Happily, however, there is no danger in this; there cannot possibly be an excess of the molybdate in the solution, except the fraction of a cubic centimetre at the very end of the titration. My original experiments, together with the subsequent experience of nearly three years, are corroborated by the above criticism of Prof. Caldwell, and they all go to prove the constancy and reliability of the process.

It may be worth noting that this is the only known volumetric process of determining phosphoric acid when iron or alumina are present, or when the solution is a nitric acid one.

The only drawback I have found—that of determining with quickness the final point of the reaction—has been very largely overcome by the happy idea of Prof. Caldwell, illustrated in his paper above.

It is evident that this little portable Bunsen filter can be used with advantage in many other volumetric methods of direct precipitation, and would doubtless give a practical nature to a variety of processes otherwise difficult or tedious.

HENRY PEMBERTON, Jr.]

* Since the publication of the above, Prof. Caldwell writes:—"To what appears in this report I might add that quite a number of additional analyses of the same fertilisers have since been made by my students, and with as good results as they get by any other method. I always use the suction filter described in the paper that you will receive, and which I think Mr. Pemberton will like as an auxiliary to his method."

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Molybdenum.—This is effected by means of the following methods, the last of which is merely approximative and should be employed conjointly with one of the other two.

1. The hydrochloric solution, distinctly acid, is saturated in the cold with hydrogen sulphide. Molybdenum sulphide is deposited and is collected upon a filter and washed with water acidulated with hydrochloric acid and saturated with sulphuretted hydrogen. The filtrate, kept for some time at 70°, and then raised to a boil, yields a further deposit of molybdenum sulphide which is collected on a filter and washed with water acidified with hydrochloric acid. After these operations the liquid is still not free from molybdenum, and is therefore concentrated and again treated as above, until after saturation with hydrogen sulphide in the cold and subsequent boiling no brown colouration is produced.

When the volume of the liquid does not exceed a few c.c. The residue of molydenum not precipitated by hydrogen sulphide may be entirely neglected, but when operating on a mixture containing much gallium and very little molybdenum, it is well to combine this process with that described under No. 3.

Red molybdenum chloride, and especially the blue chloride, are much more slowly precipitated by sulphuretted hydrogen than molybdic acid. Before treatment with sulphuretted hydrogen the lower compounds of molybdenum should be oxidised in heat, by means of a few drops of nitric acid, any excess of which will be destroyed by boiling with hydrochloric acid.

2. The precipitation of molybdenum sulphide is effected more rapidly as follows:—

The solution is supersaturated with ammonia and mixed with ammonium sulphide. Very quickly, especially at a gentle heat, there appears a yellowish-red colouration; the mixture is then supersaturated with dilute hydrochloric acid, which precipitates molybdenum sulphide. It is heated gently until the sulphuretted hydrogen is expelled, filtered, and washed with dilute hydrochloric acid.

But little molybdenum remains in the filtrate; to remove it the bulk of the liquid is reduced, destroying the ammoniacal salts by boiling with aqua regia, and the pro-

duct is treated like the original solution. Generally, after two operations thus conducted, there remains but very slight traces of molybdenum mixed with the salt of gallium; in an exact analysis the following process must be adopted:—

In spite of good washings with dilute hydrochloric acid, the molybdenum sulphide obtained as above retains a very small quantity of gallium. To be exact it is re-dissolved in aqua-regia, the nitric acid is expelled and the former treatment is repeated. As in the method No. 1, the red and blue chlorides must be previously converted into molybdic acid.

3. The solution is mixed with sulphuric acid and ammonium sulphate in quantities slightly greater than are necessary to form alum with the whole of the gallium. If the metals are not already in the state of chlorides a little hydrochloric acid is added and the solution is concentrated until crystals of alum appear on cooling; a very little hydrochloric acid is added, and the mass is agitated with three or four volumes of alcohol at 85 per cent. When the salt has been deposited it is collected on a filter, washed with alcohol at 85 per cent, and re-dissolved in water. To the new solution is added a small fragment of ammonium bisulphate, and a few drops of hydrochloric acid; it is concentrated and then treated like the original liquid.

Two or three re-crystallisations of the alum effected in this manner are sufficient to free it from any appreciable trace of molybdenum. The separation succeeds with the red and the blue molybdenum chlorides, as well as with molybdic acid. The liquids containing the molybdenum are evaporated to expel the alcohol and treated by either of the processes 1 and 2. In an exact analysis we must begin by removing the greatest possible quantity of the molybdenum in the state of sulphide; concentrate strongly, transforming the greater part of the gallium into alum, and precipitate as sulphide the traces of molybdenum contained in the final concentrated solution. As the crystallisation of the alum may be effected with the salt derived from 0·01 grm. of gallium, we see that the quantity of molybdenum escaping the action of the processes Nos. 1 and 2 in so small a volume of liquid may be neglected.—*Comptes Rendus.*

ON THE ROUGH AND READY WAY OF ESTIMATING GLUTEN IN FLOUR.

By LESTER REED, A.I.C.

Having some time ago had occasion to seek a rapid approximate method of estimating the quantity of gluten in flour, I found the following to give fairly correct results with known mixtures of white flour and starch (arrowroot being the form of starch employed in the experiments):—

The principle upon which the estimation is based is the production of a yellow nitro-body when nitric acid acts upon albumenoids. 0·5 of a grm. of flour is weighed out and carefully transferred to a test-tube, which is divided (beginning at the bottom and ending the graduation about half way up) into four parts of equal capacity; water is now to be added up to the fourth mark exactly, and the test-tube violently shaken, being closed by the cushion of the thumb. Frothing is best avoided if the shaking be terminated by successive inversions of the tube; the contents are temporarily transferred to another dry test-tube whilst the marked one is cleaned (all the pourings out are to be done immediately after shaking). A quarter of the liquid is now poured back, viz., up to mark 1, and the tubes filled up to mark 3 with nitric acid of strength such that half a test-tube full of it appears white, when a white surface is observed vertically through it, but the acid should, barring this condition, be as strong as possible. The test-tube is now to stand exactly five minutes, with occasional shaking up, and is then to be filtered immediately after shaking through a dry filter into a dry receptacle; a standard flour is to be treated in the same way and the two clear yellow solutions examined colorimetrically; the qualities of the flours are then inversely as the heights of equal colour.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London, for the Month ending June 30th, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

London, July 5th, 1883.

Sir,—We desire to submit, for the information of the Local Government Board, a statement of the particular and general results of our examination, made at the expense of the Water Companies, of 182 samples of water, collected by us within the past month at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during preceding months.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

To the Secretary of the Local Government Board.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from June 1st to June 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination, the whole without exception were clear, bright, and well filtered. In respect to aëration, and to freedom from colour and excess of organic matter, they have maintained the excellent character exhibited for some months past.

In our previous brief report for the month of May we stated that "of the 182 samples of water submitted to examination (including 26 samples of the Southwark Company's water), the whole, without exception, were clear, bright, and well filtered." The Report of the official Water Examiner on the state of the Southwark Company's water during May is as follows:—"Daily samples were taken at the works, and the water found to be clear, bright, and efficiently filtered." But in the Report to the Registrar-General for May it is written, "With the exception of the sample of the Southwark Company's supply, which was very slightly turbid, and contained moving organisms, all the water was efficiently filtered"—as usual, no information being vouchsafed as to the names and nature of these same "moving organisms." This one

sample of the Southwark water, suggested as typical of the Company's supply during the month, was drawn on May 29th, at the cab-stand near Kennington Church. Our own sample of Southwark water for the same day was taken at St. George's Church, Borough. We have, since the publication of the Report to the Registrar-General, examined afresh a reserved duplicate sample of this water, and again found it to be clear, bright, well-filtered, and free from "moving organisms," whether animal or vegetable.

In the same Report to the Registrar-General it is stated that the Thames-derived water sent out by the Companies during May "was, *for river water*, unusually free from organic matter, though not so much so as in the previous month,"—the river water thus contemned by insinuation, as queer stuff at the best, being the particular water authorised to be taken for the supply of London; and that, after full enquiry by Parliamentary and Royal Commissions, and with a full knowledge as to the fact of organic matter in a variable proportion, being one of its characteristic constituents. Elsewhere, in the same Report, this characteristic constituent of river water is spoken of as "organic impurity;" and the Thames-derived waters, even of the "unusually" good character exhibited during the month, are stigmatised as containing from 2 to 3½ times as much "organic impurity" as another variety of metropolitan water, which being derived from deep wells, is comparatively free from a constituent, however unobjectionable, that is more especially characteristic of water from rivers and lakes. As usual, it was not thought advisable to point out that, measured by the same ingeniously contrived standard, the "organic impurity" of the Glasgow Corporation's far-famed Loch Katrine water was found to be in excess of that contained in the Chelsea, Grand Junction, and New River Companies' waters.

It is interesting to note the actual quantities of organic matter met with in the river-derived water supplied to London during the past six months. The mean amount of organic carbon, as deduced from our 156 determinations, comes to 0·175 part in 100,000 parts of water. The Report to the Registrar-General for June is not yet published, but the mean results of the 30 determinations made up to May, namely, 0·183 part in 100,000 parts of water, is identical with the mean result of our 130 determinations made up to the same period. These mean amounts of organic carbon, or 0·175 for the six months and 0·183 for the five months, correspond respectively to about 0·30 and 0·32 of a grain of organic matter per gallon of water. In four samples only, out of the 156 samples examined, was the organic matter found to exceed, and that by very little, half-a-grain per gallon, a proportion falling considerably short of the thousandth part of one per cent of the water.

During the months of January and February the river was in a state of flood, and the proportion of organic carbon, and consequently of organic matter, though scarcely exceeding the proportion usually present at this season of the year, was somewhat high. A decided diminution, however, became observable in March, and has continued ever since. The middle line of the following table sets forth the average amounts of organic carbon per 100,000 parts of water, present in the entire river-derived supplies distributed during each of the first six months of the year. The upper and lower lines give the corresponding mean oxidation and colour-tint determinations, but on a special scale, different from the scales used in the monthly tables, and selected arbitrarily to show the relationships subsisting between the results of the three modes of examination. It will be observed that, despite some partial discrepancies, the parallelism is on the whole exceedingly close:—

	Jan.	Feb.	Mar.	April.	May.	June.
Mean Temperature ..	41·3°	42·8°	35·5°	46·5°	53·3°	58·9°
Oxygen from Permanganate	0·186	0·214	0·103	0·093	0·117	0·127
Organic Carbon ..	0·221	0·230	0·150	0·114	0·139	0·132
Depth of Tint ..	0·175	0·246	0·110	0·100	0·136	0·113

FIXATION OF INDIGO UPON COTTON.

By MM. SCHLIEPER and BAUM.

GRIND up for two days—

Indigo	25 kilos.
Water	100 litres
Caustic soda, sp. gr. 1·35	50 ,,
Dry caustic soda	58·53 kilos.

Care must be taken that the temperature does not rise too much during the solution of the soda, not exceeding, 40° C. This mixture keeps well and gives a better result when it has been prepared for some time.

For the printing colour there is mixed for a dark shade—

British gum	3 kilos.
Maize starch	1·50 ,,
Water	3·75 ,,
Caustic soda, at 1·35	16·00 ,,
The above mixture	30·00 ,,
	54·00 kilos.

Containing 55·5 grms. indigo per kilo. For medium and light blues, the thickening and the water remain the same, but the soda-lye is increased respectively to 28 and 40 kilos., and the indigo mixture decreased to 18 and 6 kilos., so that in the complete colour there may be 33·3 grms. and 11·1 grm. of indigo per kilo.

The British gum is maize starch only two-thirds roasted. It is essential to make use of a good thickening. According to the numerous trials of the authors maize starch is the best for this colour on account of the formation of "apparatine" which takes place under the influence of the soda-lye.

The British gum, starch and water, are mixed till completely uniform, and the soda-lye is then added by degrees, at first by half litres and then by a litre at a time, stirring well.

This operation takes an hour; at the end of this time the indigo-preparation is added and the mixture heated to 55° in the water-bath, stirring well, and then cooled immediately. The colour may be used the next day if it has taken a galatinous consistence. It must be gently heated if it has been exposed for a long time to cold or if it has not been used for months. The cloth is prepared with glucose at 7·5 to 8° B; 2½ kilos. glucose to 10 litres water.

The following are the essential points for the use of this colour.

The cloth prepared with glucose should be well dried so that the glucose may retain the smallest possible quantity of water. The colour should be very thick and little pressure should be used in printing, so that the colour should lie on the surface of the cloth and not penetrate; in other words, there must be two layers upon the cloth, one of glucose and the other of the colour. After printing it must be dried very quickly, which is easy as the colour contains but little water; but not too strongly, lest a greenish shade should be produced; it is preferable to leave the pieces slightly moist. To authors dry with air at 60—70° and with Root blowers. The object is to prevent the colour from acting upon the colour after printing; the reduction of the indigo should only take place on steaming.

Immediately after printing the pieces pass for 10 to 15 seconds into a small steaming apparatus; this time is sufficient for the complete reduction of the indigo, and if the action were prolonged the indigo would be decomposed. The steaming apparatus must be as small as possible and is placed over a reservoir of boiling water. The steam should be exempt from oxygen; the action of the air which the piece brings with it is paralysed by the strong current of steam, continually renewed in this confined space. On leaving the steam the pieces pass for two minutes into a cistern fitted with rollers and supplied with a stream of cold water. Errors committed either in preparing, drying, or steaming may reduce the result very seriously.

The only good resist is precipitated sulphur, 140 grms. of which to a litre of thickening resist the heaviest shades.

Yellow resist:—

Cadmium chloride	200 grms.
Precipitated sulphur	140 ,,
Thickening	1 litre

Red resist:—Red liquor, tin crystals, calcined starch, and 130 grms. precipitated sulphur. For nankeens and all ordinary colours use 130—140 grms. sulphur per litre.

Light Blue.—Upon cloth prepared with glucose there is printed caustic soda, at sp. gr. 1·35, thickened with British gum and maize starch; steamed for 15 seconds and padded with the indigo-colour. The glucose is destroyed in contact with the soda, the colour is only partially developed and gives a light blue. White, yellow, chamois, and light blue resists succeed easily, but for a red resist the cloth must be passed into sal-ammoniac if there is no appliance for quickly removing the soda. An indigo-colour may easily be discharged upon Turkey-reds and upon the mordant for Turkey-reds, thus producing very nice styles.

Mordant for Turkey-Reds.—We heat for three hours 40 kilos. gelatinous alumina with 64 litres caustic soda 35° B. and make up 300 litres with water. Neutralise with 8 litres hydrochloric acid at sp. gr. 1·150 and make up with water to 620 litres.

Mordant for Padding.—To 4 litres of the above mixture there is added 1 litre water. The padded cloth is dried on the drum, when it turns yellow, but resumes its original colour after ageing. The pieces are left in a heap till the morning and are then passed into cold water in a cistern fitted with rollers, well-washed, and taken through lukewarm chalk-water to convert the sodium bi- or tri-aluminate into calcium aluminate. When this mordant is ready for dyeing it can bear taking through sulphuric acid at 8°B. without losing much of its depth. It is the same with the reds dyed with this mordant. Upon this property is founded the production of indigo discharge styles.

Indigo Turkey-Red.—The cloth, mordanted for or dyed with alizarin, is saturated with glucose; the indigo colour is printed on, steamed, washed, exposed to the air for a few minutes, passed into sulphuric acid at 8° B. for 10 to 20 seconds, washed, passed into weak carbonate of soda and washed. The red pieces are soaped at a boil when the alizarin, which is under the indigo, is dissolved and the blue colour appears.

White on Turkey-red and Indigo Blue.—We print on the dark blue and a strong soda-lye and proceed as indicated. Or we print a strong lye upon the Turkey-red mordant, steam to destroy the glucose, dry, and print on the indigo. —*Moniteur Scientifique.*

ON CERTAIN REAGENTS FOR VEGETABLE ALKALOIDS.

By R. PALM.

1. *Sodium Sulphantimoniate or Schlippe's Salt.*—Some years ago I called attention to the group of alkaloid sulphides, proving that the salts of the alkaloids are precipitated with a yellowish colour by solutions of alkaline sulphides and persulphides, and I have further demonstrated the existence of alkaloid double sulphides, which are formed when solutions of alkaloid salts come in contact with the solution of sodium sulphantimoniate. The characteristically-coloured precipitates thus produced consist of alkaloid sulphide + antimony sulphide.

On mixing very dilute solutions of the alkaloids, and of the reagent, both as neutral as possible, the precipitations appear at first colourless, or milky suspensions; on exposure to the air they turn more or less yellowish and in concentrated solutions they appear at once yellow, or in different shades up to a reddish-brown, and in saturated solutions there are formed resinous masses.

In dilute solutions the precipitation is more complete than in the more saturated. Gentle heat and the addition of strong alcohol promote the separation. An excess of sodium sulphantimoniate dissolves the first-formed yellow precipitate in most cases. The double sulphides are, with few exceptions, amorphous, and dilute acids extract the alkaloid from them but partially. The reactions are in general sensitive, but I have not yet succeeded in ascertaining either their limits or the chemical constitution of these double salts.

Antimony-quinine Sulphide.—In dilute, neutral solutions of quinine sulphate, the reagent produces merely a milky turbidity; in strong solutions there is formed at once a yellow flocculent precipitate which, on shaking, coagulates in resinous lumps and becomes gradually darker. On mixing together hot solutions there are formed at once resinous masses, which, when dry, fall to a fine yellow powder, like lead iodide. In a strong solution the precipitation is imperfect, since ammonia throws down quinine from the filtrate. In dilute solutions the precipitation is more complete.

Antimony-cinchonine Sulphide.—In a dilute solution of cinchonine sulphate the reagent gives at once a flocculent precipitate which coagulates neither on standing nor on the application of gentle heat. The precipitate is darker than that of quinine, almost of a leather colour, and it is more complete than that of quinine.

Antimony-quinidine Sulphide.—With quinidine sulphate the reagent behaves almost exactly as with quinine sulphate, but with this difference, that on shaking or on mixing warm solutions only a part of the deposit collects in resinous masses, the rest falling as yellow flocks. The entire precipitate when dry is of a deeper yellow than those of quinine and cinchonine, resembling an intense, dark chrome yellow. The precipitation is more complete than that of quinine sulphate.

Antimony-morphine Sulphide.—In a dilute solution of morphine chloride there is produced at once a yellowish flocculent deposit; in strong solutions the precipitate is darker, but less complete. The precipitate, when dry, has the colour of powdered gamboge.

Antimony-codeine Sulphide.—In the solution of codeine chloride the reagent gives immediately a flocky precipitate. In dilute solutions the precipitation is more complete than in the more concentrated. The colour of the deposit when dry is paler yellow than that of morphine, resembling in its tone that of quinidine.

Antimony-narcotine Sulphide.—In concentrated and in hot solutions the precipitates coagulate in resinous masses. The reaction is much more sensitive than in case of the two foregoing opium-alkaloids. The deposit when dry has the colour of precipitated and dried ferric hydroxide.

Antimony-strychnine Sulphide.—Even in very dilute solutions of strychnine nitrate the reagent occasions a flocculent precipitate, colourless at first, but gradually turning to a pale yellowish colour, on exposure to the air. In concentrated solutions there is formed at once a rich yellow, homogeneous flocculent precipitate, which even on prolonged standing does not coagulate. The reaction is more sensitive than with all other vegetable alkaloids, the strychnine being entirely thrown down. The colour of the deposit when dry is a fine, intense, deep golden-yellow. The precipitate is not soluble in an excess of the reagent.

Antimony-brucine Sulphide.—If the reagent is added in successive portions to a moderately concentrated solution of brucine nitrate three distinct precipitates can be plainly observed.

a, a reddish yellow, which collects in resinous masses; *b*, a light golden yellow flocculent deposit; and *c*, a colourless, flocculent deposit, which collects in crusts on the surface of the liquid.

On boiling the mixture of these three precipitates in water the greater portion dissolves, leaving an amorphous, deep-orange residue. From the filtrate there crystallises

out, in the course of ten minutes, a pale yellow double sulphide in fine acicular tufts.

The liquid filtered from these crystals is still bitter, and if placed in a refrigerating mixture there is deposited in the course of a few hours a pale yellow, crystalline powder which is also a double sulphide. Crystalline deposits form also at common temperatures in the liquid filtered from the precipitate without previous boiling with water.

Antimony-atropine Sulphide.—In a strong solution of atropine sulphate the reagent occasions at once a yellowish deposit, which coagulates on shaking or heating. The reaction is not very sensitive and the colour of the dried precipitate is a lighter yellow than that of morphine.

Antimony-bebeerine Sulphide.—The reagent produces in the solution of bebeerine chloride an immediate dark-coloured precipitate, which coagulates in strong and especially in hot solutions. The colour of the double sulphide when dry is a greyish brown. All the double sulphides above mentioned are very stable. That the alkaloid sulphides can form double combinations with other metallic sulphides which are soluble in alkaline sulphides can scarcely be doubted.

II. *Lead Chloride as a Reagent for Vegetable Alkaloids.*—For this purpose we may use a solution of lead chloride either in water or in sodium chloride, which dissolves more lead chloride than pure water. The solution in either case is prepared hot. The alkaloids must not be employed as sulphates, as the lead would be precipitated by the sulphuric acid. The acetates, nitrates, or chlorides may be used—the last mentioned by preference. Most of the vegetable alkaloids are precipitated by this reagent in a colourless, finely crystalline state. The reaction is less sensitive than that of sodium sulphantimoniate. The precipitates obtained consist of lead chloride and an alkaloid salt.

Quinine is thrown down in pulverulent crystals; cinchonine, morphine, and codeine in small, fine needles. Strychnine, when dry, forms an asbestos-like, felted mass, showing distinct crystalline forms. Brucine gives a fine crystalline powder. In many alkaloids the crystalline deposits appear only after prolonged standing.

III. *Sodium Chloride as a Reagent for Bebeerine.*—Sodium chloride show a remarkable behaviour with bebeerine chloride, the alkaloid of the tree *Nectandra Rodia*. If a strong solution of sodium chloride is mixed with a solution of the alkaloid, the latter is completely re-precipitated and with its original dark colour. Even in very dilute solutions of the alkaloid the separation is complete. This process might be utilised for the industrial preparation of bebeerine.—*Zeitschrift fur Analytische Chemie.*

FORMATION OF SULPHIDES BY COMPRESSION. CONSIDERATIONS THENCE DERIVED CONCERNING THE PROPERTIES OF THE ALLOTROPIC STATES OF PHOSPHORUS AND CARBON.

By M. W. SPRING.

The author has previously shown the possibility of uniting the fragments of solid bodies by the sole action of pressure. He also established at the same time the possibility of forming chemical compounds by means of pressure. Thus he obtained cuprous sulphide by compressing a mixture of sulphur dust and copper; mercuric iodide, by compressing mercuric chloride with potassium iodide, &c. Finally, by compressing in the same manner mixtures of the filings of different metals, he formed alloys having for equal compositions the same melting-points as those obtained by fusion.

The last-mentioned facts certainly establish the possibility of causing bodies to enter into chemical reaction by the mere agency of a mechanical energy. This result is closely linked with another obtained during the course of the same investigation: the polymerisation of certain simple bodies, *e.g.*, sulphur, by the action of pressure. The author had drawn a general conclusion from his experiments, and had announced that matter takes, below a given temperature, a state corresponding to the volume which it is compelled to occupy.

He has since undertaken a methodical study of the chemical reactions accomplished by the action of pressure. He had already shown the possibility of forming metallic arsenides by compressing mixtures of arsenic and of the filings of different metals (*Bulletin d l'Académie Royale de Belgique*, t. v., 1883), and he now communicates the results obtained by compressing mixtures of sulphur and of certain metals or non-metals. The results not merely confirm the author's former conclusions, but they throw a new light on the relations of organic and inorganic chemistry, and exhibit the so-called simple bodies as capable of assuming a peculiar constitution varying according to the conditions in which they are placed, and the actions to which they are submitted.

He used the metals in the state of fine filings intimately mixed with flowers of sulphur previously thoroughly washed. The mixtures were made in atomic proportions and were submitted to a preliminary pressure of 6500 atmospheres. They then assumed the state of a hard compact mass, showing, on examination with the microscope, that the reaction of the sulphur and the metal had taken place wherever the elements were in contact. The mass obtained was then reduced into fine powder and compressed again from twice to eight times.

1. Sulphur and Magnesium.—After six compressions there was obtained a grey mass with a feebly metallic surface-lustre. It dissolves in water at 50° to 60° with a slow escape of hydrogen sulphide, the liquid becoming of a golden yellow. A drop of hydrochloric acid occasions immediately a very strong escape of hydrogen sulphide, whilst free sulphur is deposited. Hence magnesium and sulphur combine under the action of pressure, forming magnesium sulphide and possibly a poly-sulphide.

2. Sulphur and Zinc.—Three compressions yield a block deceptively similar to native blende with metallic lustre. Dilute sulphuric acid dissolves the block slowly with an escape of hydrogen sulphide.

3. Sulphur and Iron.—After four compressions a block is obtained which the file scarcely touches. Dilute sulphuric acid dissolves it easily with continuous escape of hydrogen sulphide. If the product of compression is heated in a closed tube no luminous phenomenon is observed, the body entering into tranquil fusion. Hence the potential heat of the free sulphur and iron has been realised during the compression.

4. Sulphur and Cadmium.—Three compressions give a yellowish grey homogeneous mass. The powder is yellow, but less pure than that of cadmium sulphide obtained by precipitation. Strong hydrochloric acid dissolves the mass with escape of hydrogen sulphide.

5. Sulphur and Aluminium.—Result incomplete. After five compressions a mass is obtained which, in contact with moist air, gives off an odour of hydrogen polysulphide.

6. Sulphur and Bismuth.—The combination takes place with great ease.

7. Sulphur and Lead.—The combination is still more easy.

8. Sulphur and Silver.—The action is slow; eight compressions are necessary.

9. Sulphur and Copper.—Three compressions complete the combination. When the product of the compression is heated there is no development of heat or light.

10. Sulphur and Tin.—Three compressions give a block which yields a yellowish grey powder, easily soluble in a hot solution of sodium sulphide. Stannic sulphide is therefore formed by the compression of sulphur and tin.

11. Sulphur and Antimony.—After two compressions

we obtain a grey-black mass having the colour and lustre of stibine. When powdered it dissolves with ease in hot hydrochloric acid, giving off hydrogen sulphide.

12. Sulphur and Red Phosphorus; Sulphur and Carbon.—Result entirely *nil*; there is produced not the least trace of phosphorus sulphide nor of carbon sulphide.

Conclusions to be drawn from these Facts.

The negative results just mentioned have an especial interest. It is established that red phosphorus has a higher specific gravity than white phosphorus, that of the former being 1·96, and that of the latter 1·82. The author's former researches (*Bulletins de l'Académie Royale de Belgique*, 49, p. 323, 1880) have shown that if sufficient pressure is applied to a body capable of assuming several allotropic states, it takes under pressure the state corresponding to its greatest density. It is consequently impossible to transform red phosphorus into white phosphorus by pressure. But we know, on the other hand, that sulphur and red phosphorus may be mixed with impunity at common temperatures without combination ensuing; to produce combination the temperature must be raised to about 260°, the point of transformation of red phosphorus into white phosphorus.

It is thus established that red phosphorus must first be changed from its allotropic condition before entering into combination with sulphur. The pressure opposing this change renders also the act of combination impossible; red phosporus appears to us like a body which has lost its chemical faculties.

Thus, the combination of an element with itself, *i.e.*, its polymerisation, has really the effect of extinguishing its energy, rendering it incapable of fulfilling certain functions. The chemistry of red phosphorus, more simple than that of white phosphorus, may be considered as the chemistry of a deadened body. The phosphorus which is found in combination with sulphur in phosphorus sulphides, and that which enters into combinations of other kinds, is certainly not phosphorus in the red state; it is even possible, if not probable, that it is not even white phosphorus, but a substance still unknown in the free state.

We arrive at a similar but more complete conclusion as to the nature of carbon. It is known that the affinity of carbon for sulphur and even for oxygen only becomes manifest at a temperature bordering upon redness. Is not this tantamount to saying that in order to enter into combination with another body, carbon, like red phosphorus, must first change its allotropic condition. This view is supported by the following considerations:—The specific heat of amorphous carbon, and, *a fortiori*, that of graphite and diamond, form exceptions to the law of Dulong and Petit; they are too small by more than one-half. They would be normal if the atomic weight of carbon were greater than it really is; in other words if free carbon were a polymer of combined carbon. Rose has found that at a temperature of about 500° the specific heat of carbon agrees with the law of Dulong and Petit. At this temperature carbon undergoes a beginning of depolymerisation, *i.e.*, its chemical affinities reappear, and it burns readily in oxygen. Do not these facts show a complete parallelism between the chemical history of phosphorus and that of carbon?

Crystalline carbon, and even free amorphous carbon, are without chemical activity at the ordinary temperature; but when, in consequence of a rise of temperature, they take another state, they are transformed into a new kind of carbon, constituting a fourth allotropic state, and endowed with a prodigious capacity of combination. If these conclusions are well founded, we may venture a step further and ask if the carbon which enters into the composition not of mere *organic* compounds but of organised bodies, is not a carbon of still another allotropic state, characterised by the appearance of new properties or forms of combination which find their expression in the vital phenomena

In other words, a derivative of carbon, before forming part of a living body, must first undergo in its atoms a transformation similar to that which permits amorphous carbon to enter into the composition of organic compounds. In this order of ideas the carbon of organic chemistry would be merely a first deadened form of the carbon of biological chemistry, whilst free carbon is merely the defunct remains of the carbon of organic chemistry.—*Bulletin de la Société Chimique de Paris.*

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS.

The Analysis of Soap.

(Concluded from page 52.)

Method III. (Cairn's "Manual of Qualitative Analysis," page 244, somewhat modified.)

Water.—Dissolve 1 to 2 grms. in the smallest possible amount of strong alcohol, pour the solution upon sand in a dish, the sum of whose weight and that of the sand has already been determined, and dry in air-bath at 110° C., to constant weight.

[The objections to this method are that the weight taken is so small that it may not represent a fair average. It is difficult to transfer a strong alcoholic solution without considerable washing, and so increasing the volume of the alcohol to be evaporated. Great care is requisite in evaporating the solution not to lose by spirting, even when the evaporation is conducted on a water-bath heated with a very small flame. The sand as well as the soap is hygroscopic, and even if, after ignition, the sand is allowed to cool to 110° in an air-bath before being transferred to a desiccator previous to weighing, the results are not accurate. It is not unusual to state as part of a soap analysis "water by difference," but in this case the direct determination of the water should be given also.—L.]

Solution.—Dissolve 5 grms. of the soap in 100 c.c. of 90 p.c. alcohol by warming on water-bath to 40° to 50° C.—Filter through a weighed filter-paper.—(A.) Filtrate. (B.) Residue on filter.

(A.) Filtrate. Precipitate the uncombined alkali as bicarbonate ($NaHCO_3$) by passing a slow stream of well-washed carbonic acid through the filtrate. Allow the well-covered beaker glass to stand until the liquid is clear, warm on the water-bath, filter, and wash with warm alcohol. Dissolve the precipitate in water, titrate with normal sulphuric acid, and calculate to NaHO for *uncombined alkali.*

Combined Fatty Acids.—Transfer the filtrate or the alcoholic solution in which CO_2 failed to produce a precipitate to a flask, add 100 c.c. water, and evaporate, or preferably distil off the alcohol. Add 15 c.c. of normal sulphuric acid and 5 grms. pure white wax, boil, filter through a wetted filter, and wash with boiling water until the washings are no longer acid. After pressing and drying between filter-papers, the weight of the cake, less the weight of wax added, is the sum of the weights of the combined fatty acids, uncombined fat, and resin.

[I failed in attempting to carry out these directions. The soap and wax were almost entirely in one large cake, but some was left after boiling on the sides of the beaker, and could not be removed by mechanical means. The use of solvents was likewise attended with difficulties and objections. By heating at 100°, however, until every trace of water was driven off and the weight became constant, and deducting the weight of the beaker, a result was obtained nearly identical with that found by Method IV.—L.]

Combined Alkali.—Titrate by normal soda solution the filtrate from the wax in order to find how much of the sulphuric acid has been neutralised by the combined alkali of the soap. Calculate to Na_2O.

(B.) *Residue.*—Wash the residue on filter with hot alcohol, dry at 110°, and weigh. Wash with water, dry at 110°, and weigh. The last weighing gives the *insoluble residue*. The wash water which contains the free carbonate is titrated with sulphuric acid, and the result calculated to Na_2CO_3.

Uncombined Fat.—Treat 5 grms. of the soap (cut into very fine shavings) with ether two or three times, pouring off the ether into a weighed dish. The operation may be assisted by placing the vessel over a water-bath containing hot water, but with no flame under it. Since the ether may dissolve small portions of the soap, it is safer to evaporate off the ether from the first extraction, and then to treat the residue again with ether. The weight of the residue left on the last evaporation of the ether gives (2) uncombined fat. Carbon disulphide may be used in place of ether.

[Complete and satisfactory extraction with ether is troublesome to effect in an open dish.—L.]

Resin.—Dissolve 40 grms. of the soap in boiling water, add an excess of sulphuric acid to separate the fatty acids and resin; cool, pour off the aqueous portion, and digest the fatty residue with equal volumes of alcohol and water, agitating from time to time. Pour off the milky fluid, add more alcohol and water, and digest again. Repeat this until the fluid ceases to become milky, then add water and a weighed quantity of wax as before, filter, dry, and weigh the cake. The weight represents that of the fatty acids deprived of the resin. The difference of percentage obtained in this way from the percentage obtained as above described gives approximately the amount of the resin present.

[This method is very difficult of execution, and gives only approximate results.—L.]

Glycerin.—Dissolve 5 grms. of the soap in 90 per cent alcohol, add dilute alcoholic sulphuric acid (1 vol. sulphuric acid to 10 vols. alcohol) so long as a precipitate forms, wash with alcohol, digest with barium carbonate and alcohol until the alcohol is gone, filter, evaporate the filtrate to dryness in a weighed dish, and weigh the residue of glycerin.

[This residue should be entirely soluble in water, and should be carefully tested to see whether, as is probably not the case, it is pure glycerin.—L.]

Mineral Constituents.—Calcine 5 grms., dissolve in water, filter, wash, dry at 110°, and weigh the *insoluble residue*. Dilute to 100 c.c. In 25 c.c. determine *total alkali* by titration with half-normal sulphuric acid. In another 25 c.c. determine *chloride* by titration with standard silver nitrate, using potassium chromate as indicator. In a third 25 c.c. determine *sulphate* with barium chloride. In the last 25 c.c. determine *silicic acid* by evaporation to dryness with hydrochloric acid.

[This makes the sixth separate weighing of different portions of the sample, and contemplates the determination of two previously-determined constituents. By ignition with so much organic matter any sulphate present is partly reduced to sulphide.—L.]

Method IV. (By Julius Loewe, Fresenius's *Zeitschrift* xix., p. 112.)

Water.—8 to 10 grms. of the soap in fine shavings is heated first at 60° to 70°, then at 100° to 105° to constant weight. In order to prevent absorption of CO_2 by the free alkali, the desiccation should be performed in an atmosphere free from CO_2.

Uncombined Fat.—The thoroughly dried soap which has been used in the water determination is treated two or three times with warm benzol or petroleum ether in a tall covered beaker. After each treatment the liquid is allowed to stand until clear, and decanted into a tared flask. If the liquid cannot be safely decanted it is filtered through a weighed filter, which is afterward employed for the alcoholic solution of the soap. The filtrates are finally distilled, and the weight of the residue in the flask, after drying at 110°, gives the uncombined fat

The residue from the uncombined fat is treated with eight to ten times its weight of 90 p.c. alcohol, and warmed on water-bath to 40° to 50°. The fatty acids along with the caustic alkali and glycerin are dissolved, while soda carbonate, potato starch, and mineral matters remain undissolved, and after washing with hot alcohol and drying at 100°, are weighed. In the better soaps for household use, only a residue of 1 to 1·5 per cent at the highest, and consisting mostly of soda carbonate, should remain.

Examination of this Residue: Starch Meal and Mineral Constituents.—Wash with cold water until the filtrate amounts to exactly 60 c.c. Wash the filter, and precipitate with alcohol until it has taken the place of the alcohol, dry at 100°, and weigh. The weight gives the amount of insoluble organic matters, like starch, &c. (which should be further examined under the microscope), and insoluble mineral matters.

In 15 c.c. of the 60 c.c. filtrate determine the quantity of carbonic acid set free by acid, and calculate therefrom the quantity of soda carbonate.

[This method of estimation is less convenient than that by titration, as before given, and no more accurate.—L.]

In another 15 c.c. determine the chloride, and in another the silicate.

Uncombined Alkali.—The filtrate from the above residue is treated with CO_2, the beaker well covered is allowed to stand on a water-bath until the supernatant liquid has become clear, and the precipitate of carbonate is filtered and washed with warm alcohol.

Combined Alkali.—The alcoholic filtrate is treated with alcoholic sulphuric acid (1 : 10) as long as precipitation occurs; after standing, the precipitated sodium sulphate is filtered off, collected on a weighed filter, washed with alcohol, dried at 110°, and weighed. From this weight is calculated that of the combined alkali.

Combined Fatty Acids.—To the filtrate acidified with sulphuric acid water is added in a platinum dish, and the alcohol expelled by heating. After cooling, the fatty acids are separated by filtration.

Glycerin.—The filtrate is treated with barium carbonate to remove the excess of sulphuric acid, and contains the glycerin.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Professor of Chemistry and Physics in the University of Cincinnati.

SILVER, POTASSIUM, SODIUM, CHLORINE, BROMINE, IODINE, AND SULPHUR.

(Concluded from p. 54).

We are now in a position to determine more closely the molecular weights of the haloid salts which we have already been considering.

For silver chloride, still employing the formula for the probable error of the last term of a proportion, we get the following values:—

From (5)	AgCl =	143·062	± 0·032
From (13) and (F) ..	„	143·032	0·014
From (17) and (21) ..	„	143·108	0·034
From (18) and (26) ..	„	143·061	0·041
From (19) and (27) ..	„	143·035	0·033
General mean.. ..	„	143·045	± 0·0108

Subtracting from this the atomic weight of silver, 107·675, ± 0·0096, we get for the atomic weight of chlorine, Cl = 35·370, ± 0·014.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

For silver bromide we have these results:—

From (6)	AgBr =	187·453	± 0·043
From (14) and (G) ..	,,	187·440	0·018
From (18) and (25) ..	,,	187·454	0·053
General mean	,, =	187·443	± 0·016

Hence using the general mean for silver as above, Br = 79·768 ± 0·019.

Silver iodide comes out as follows:—

From (7)	AgCl =	234·195	± 0·053
From (15) and (H) ..	,,	234·237	0·023
From (19) and (25) ..	,,	234·240	0·054
General mean	,,	234·232	± 0·019

Hence I = 126·557 ± 0·022.

For the molecular weight of sodium chloride we have:—

From (4)	NaCl =	58·366	± 0·0137
From (9) and (E) ..	,,	58·368	0·0056
General mean	,,	58·3676	± 0·0052

Hence if chlorine = 35·370 ± 0·014, then Na = 22·998 ± 0·011.

For potassium chloride:—

From (1)	KCl =	74·4217	± 0·016
From (10) and (B) ..	,,	74·4041	0·007
From (17) and (25) ..	,,	74·3975	0·017
General mean	,,	74·4057	± 0·0062

For potassium bromide we get:—

From (2)	KBr =	119·117	± 0·096
From (11) and (C) ..	,,	118·810	0·0118
General mean ..	,,	118·815	± 0·0117

And for potassium iodide:—

From (3)	KI =	165·210	± 0·053
From (12) and (D) ..	,,	165·502	0·029
General mean	,,	165·432	± 0·026

Now, taking the molecular weights of these three potassium salts in connection with the atomic weights just found for chlorine, bromine, and iodine, we get these values for potassium:—

From the chloride	K =	39·036	± 0·016
From the bromide	,,	39·047	0·022
From the iodide	,,	38·875	0·034
General mean	,,	39·019	± 0·012

Finally the three sulphur ratios give us three estimates for the atomic weight of sulphur. In the third of these I have applied the "A" value for silver and the general mean for silver chloride:—

From (8) and (I)	S =	31·968	± 0·014
From (16) and (I)	,,	31·995	0·032
From (20)	,,	32·041	0·028
General mean	,,	31·984	± 0·012

We may now appropriately compare the results of this discussion with the atomic weights deduced by Stas from his own experiments only. His values are given under two headings:— one for oxygen = 16, the other for O = 15·96. As we have been using the figure 15·9633 for oxygen, here is at the outset a discrepancy. Starting from this value we found:—

Ag =	107·675	± 0·0096
Cl =	35·370	0·014
Br =	79·768	0·019
I =	126·557	0·022
Na =	22·998	0·011
K =	39·019	0·012
S =	31·984	0·012

If we assume 16 to be the true figure for oxygen, we get the following results, which I have placed in a column parallel with the values found by Stas:—

	The New Values.	Stas.	Differences.
Silver ..	107·923	107·930	0·007
Chlorine	35·451	35·457	0·006
Bromine	79·951	79·952	0·001
Iodine ..	126·848	126·850	0·002
Sodium ..	23·051	23·043	0·009
Potassium	39·109	39·137	0·028
Sulphur ..	32·058	32·074	0·016

These differences are insignificant. No other criticism could more severely test the character of Stas' work, or more definitely illustrate his magnificent accuracy of manipulation.

NOTICES OF BOOKS.

The "A B C" of Modern Photography: comprising Practical Instructions in Working Gelatine Dry Plates. By W. K. BURTON, C.E. London: Piper and Carter. 1883.

THIS little manual is intended to fill a small gap in photographic literature on the working of dry gelatine plates, pre-supposing that the beginner possesses no knowledge of photographic operations. To suit the purposes of those amateurs who are artistically inclined but are deficient in scientific acquirements and manipulative skill, the subject is treated in a purely technical manner, all theory being carefully ignored. The instructions that are given for the working of this beautiful process are concise and clear, written in a style eminently suited to meet the requirements of non-scientific individuals. The first few chapters are devoted to the selection of the most economical apparatus to suit a beginner, the preparation of the chemicals required, and the arrangement of the "dark" room. Having got his appliances into working order, the art aspirant is at once started on his first experiment of exposing a plate, and the instructions given in order to secure success in this fickle operation are as clear as could be expected: with these before him, supplemented with a little experience, any tyro ought in a very short time to conquer some of the difficulties connected with this operation.

The chapter on lenses, we think, might have been extended, even at the expense of a little of the theory of optics, and the drawings that are given lettered, as well as the various parts of this, the most important instrument of the photographer, described. As addition to this matter, a separate chapter is given, with tables to facilitate judgment of exposure for different lenses. The defects peculiar to the gelatin dry-plate process and their remedy are fully explained, and finally the necessary operations for obtaining a "positive" are given in detail.

That this little book has in but a few months reached a third edition proves clearly its usefulness as a guide to dry-plate photography, and we think that any beginner following carefully the rules here laid down ought in a very short time to succeed in turning out a fair picture, or even in "perpetrating a portrait."

A Treatise on Electricity and Magnetism. By E. MASCART and J. JOUBERT. Translated by E. ATKINSON, Ph.D. Volume I. London: Thos. De la Rue and Co. 1883

THE English student of electrical science must be considered remarkably fortunate in having expressed in his

own language many of the most brilliant ideas that have yet emanated from the human intellect bearing upon this subject, as well as the development and concise mathematical statement of these ideas. The great influence that Faraday's method of conceiving electrical phenomena, as expounded in his Researches, has exercised over scientific men since his time cannot be over-estimated, and although his ideas were expressed in lengthy sentences, but none the less clear, it was left for the able mathematicians who succeeded him to show that his conceptions were of a strictly mathematical order, and capable of being symbolised and developed by the ordinary mathematical operations, by so doing basing the science on the surest of all foundations. Clerk Maxwell's great work on the science may be said to mark the beginning of a new era in the history of the advance of electricity, and by the translation of Faraday's ideas regarding lines of force and the part played by the medium in which electrical and magnetic actions take place into mathematical symbols, he did much to elucidate many of the phenomena and to annihilate empty space. Since the publication of this work, ten years ago, numerous treatises on this branch of science have been produced, and in each and all of these may be seen how much the various writers have been indebted to Maxwell, and the great influence his book has exercised over the conceptions and treatment of electrical phenomena.

The addition to the literature of electricity now before us, which is based upon a course of lectures delivered by one of the joint authors at the College de France, judging by the first part, gives promise of being one of no little value to the mathematical physicist by the clear and concise manner in which this difficult subject is handled. The style of the work is explained by the authors expressing the idea which has guided them by considering it as an essay on the mechanical theory of electricity. The present volume is divided into four parts, in which Statical Electricity, Electrical Currents, Magnetism, and Electro-Magnetism are respectively discussed from a mathematical point of view, many of the demonstrations of the theorems being remarkable for their neatness and simplicity, without detracting from their generality; but to digest all the matter that is here brought together would require a much greater depth of mathematical reading than is to be found amongst the average students of physics.

The characteristic feature of the book is the excellent plan of introducing many particular cases as problems, and effecting their solution by the principles developed, in which way only a student can ever hope to obtain a firm grasp of a mathematical subject. By so doing the difficulties in the way of reading Maxwell's work, owing to its generality, are rendered less perplexing, and the student learns the true meaning of the symbols with which he works.

The properties of fluids are invariably introduced by writers on electricity by way of analogy, with advantage, to facilitate the conception of many of the ideas, but it does not seem reasonable to designate by "flow of force" what Faraday called "number of lines of force," as is here done, or to speak of the "mass of electricity" for charge or quantity, or of the "emission and absorption of force by electrical masses."

No special chapter is given to spherical harmonics, although the analyses are occasionally introduced. This might have been of use to the student, also for the benefit of those who have not read Fourier's mathematical "poem," a short outline of the method by which the equations connected with the flow of electricity along wires are solved. Considering the mass of symbols that are employed in this treatise, so far as we see it, it is wonderfully free from errors. On page 17 occurs r for r'; Laplace's equation is written on page 37 with x instead of z; and in the value of the definite integral on page 218 a 2 is dropped.

Should the second volume promised, which is to be more of an experimental character, be of the same standard of excellency as the present one, the literature of electricity will have obtained a highly valuable contribution, and the student of the science will have a complete, clear, and deep text-book from which to acquire a thorough knowledge of electricity.

Calculations of Densities and Expansions. By H. J. Chaney. London: George E. B. Eyre and Wm. Spottiswoode. 1883.

The contents of this small pamphlet, issued by the Standards Office, Board of Trade, consist of a number of valuable formulæ and tables relating to the corrections necessary to be made for change of pressure and temperature in the weight of air and of water in determining the true weight and density of solid bodies. The pamphlet is divided into four sections, the first three being on the weight of air, the expansion of water, and the expansion of solid bodies respectively, and contain the formulæ employed in applying the corrections for temperature and pressure, with examples illustrative of their use, the fourth section giving the numerics relating to these formulæ. In some of the tables that are here given, the data on which they were based when they were originally drawn up in 1856 have been re-examined, and although a few alterations have been made in the data the new tables do not differ appreciably from those contained in the papers of Prof. W. H. Miller and Sir G. B. Airy, to be found in the *Philosophical Transactions* for that year.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 4, July 23, 1883.

Historical Part Played by the Invention of Artificia Soda obtained from Common Salt.—M. Dumas.—An eloquent survey of the industrial consequences of this invention delivered in connection with the proposal of the municipality of Issoudun to erect a monument in honour of Nicholas Leblanc.

Origin of the Combined Nitrogen existing on the Surface of the Earth.—A. Müntz and E. Aubin.—The authors show that the only noteworthy agent for the production of nitric or nitrous acid from the free nitrogen of the atmosphere is the electric discharge. They consider that unless the supply of the oxides of nitrogen thus generated is greater in tropical regions than it has been found to be in Europe it will be difficult to explain, by electricity alone, the compensation of the nitrogen which is incessantly wasted, and especially the accumulation of combined nitrogen which exists on the surface of the globe. Hence another cause must be sought for the production of nitrogenous compounds. It has been proved by the experiments of M. Boussingault upon plants, and those of M. Schlœsing upon the soil, that neither of these is able to assimilate free nitrogen. Hence the authors are inclined to seek the source of combined nitrogen in the violent combustions which must have ensued at a certain stage of the earth's existence, when the elements which had been dissociated by an elevated temperature re-combined in presence of oxygen and nitrogen, involving the formation of nitrous compounds. It is known, indeed, that large quantities of nitrous acid are formed whenever any body is burnt in air. According to the authors' experiments, 1 grm. of hydrogen burning in air yields as much as 0·001 grm. nitric acid, whilst 1 grm. yielded as much as 0·100 grm. Hence, at the first appearance of organic beings upon the earth, there existed a large stock of nitrogenous compounds in the air and the soil upon which we are still subsisting, and which is decreasing

under the influence of the causes which effect the escape of free nitrogen unless the supply is kept up by the action of atmospheric electricity.

A Universal Galvanometer Free from Oscillation for the Rapid Measurement of Currents of Great Intensity and of High Tension.—M. Ducretet.—This instrument cannot be intelligibly described without the accompanying figure.

Formation-Heat of the Potassium Fluorides.—M. Guntz.—The author gives the formation-heat of the anhydrous fluoride, of the crystalline salt with 4 mols. of water, and of fluo-potassium hydrofluoride.

Nitro-derivatives of Ethylene Hydride.—A. Villiers.—The author continues the study of a compound of tetra-nitro-ethylene bromide and of potassa, described *Comptes Rendus*, xciv., p. 1122. He also examines the action of nitric acid upon bromised ethylene bromide.

Certain Derivatives of Mannitic Hexylene.—L. Henry.—The author has obtained and examined hexylenic mono-chlor-hydrine, mono-brom-hydrine, mono-iod-hydrine, aceto-chlor-hydrine, chloro-nitrine, dinitrine, hexylene bichloride and monochloride, and hexylenic acetone.

Products derived from the Bacterian Fermentation of the Albumenoids.—Arm. Gautier and A. Etard.—In a former communication (*Comptes Rendus*, xciv., pp. 1357 and 1598) the authors have described the products obtained by the splitting up of the albumenoids under the action of putrid ferments. They now show that whatever may be the albumenoid matter which is putrefying and up to a certain point, the variety of the putrid ferment, the principal ptomaines—as obtained from the flesh of mammalia, of fishes and mollusca, and from the white of eggs, &c.—are constant in properties and in composition.

Alleged Transformation of Brucine into Strychnine.—M. Hanriot.—Sonnenschein announced (*Berichte Deutsch. Chem. Gesell.*, viii., p. 212) that on gently heating brucine with dilute nitric acid, carbonic acid escaped, while there remained behind a solution containing a yellowish resin (the cacotheline of Laurent, Gerhardt, and Hofmann) and strychnine. The author, on experimenting according to Sonnenschein's directions, but with perfectly pure brucine, did not obtain a trace of strychnine. Hence he ascribes Sonnenschein's result to the use of an impure brucine. If brucine is mixed with even one-half of strychnine, the latter cannot be detected by its ordinary reaction. Brucine thus, like morphine, quinine, methylic alcohol, &c., masks the reaction of strychnine. As regards the physiological action of brucine, the question arises whether the samples experimented with were really pure?

Combustion-heat of Coal.—M. Scheurer-Kestner.—The author defends the results obtained by M. Meunier-Dollfus and himself (*Comptes Rendus*, lxvi., p. 1047) against the criticisms of MM. Bunte and Stohmann, who consider the figures of M. Scheurer-Kestner too high.

Bulletin de la Société Chimique de Paris.
No. 1, July 5, 1883.

Transformation of Glycolide into Glycolic Acid.—M. de Forcrand.—The author determines the sign and the quantity of the heat produced in this transformation.

Russian Chemical Society.—Session January 6/18, 1883.—M. Beketoff has examined if the displacement of a metal by another metal in the moist way has a limit. He finds that at ordinary temperatures it is effected on the principle of maximum work.

MM. Alexeef and Kissel communicated the conclusion of their researches on azo-cuminic acid.

M. Kissel sent in a study on the action of the alkalies in presence of nascent hydrogen upon nitrethane and secondary nitro-propane.

M. Bogdanoff gave an analysis of the clays of Kiew.

M. Tchirikoff presented an apparatus for demonstrating the combustion of ammonia.

M. Kondakoff gave analyses of the refractory sulphuretted clays of Bachinot.

M. Koukline has studied the specific-heat and the evaporation-heat of certain of the products obtained by the fractionated distillation of petroleum.

M. Gustavson explained his researches on the action of aluminium bromide upon the bromides of the alcohol radicles and upon ethylene in presence of hydrobromic acid.

M. Gawriloff communicated a note on the composition of the humus of soil taken in the Goverment of Tula.

M. Gustavson gave an opinion on the mode of combination of iron and aluminium phosphates with humus.

M. Krustchoff sent a note on the solution-heat of saline mixtures.

M. Mendelejeff described a new apparatus for the determination of vapour-densities.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 5.

Seeds of Weeds existing in Arable Soils.—H. Putensen.—From the observations undertaken the number of such seeds existing in the soil is found to be almost incredibly great.

Manurial Experiments at the Kiel Agricultural Station.—Prof. A. Emmerling.—Ammonia had a slight action upon clay soil, the extra outlay having been fully compensated in two cases only. On sandy soils the results were very unfavourable. On black soil, rich in humus, the returns were good. Superphosphate proved more or less superior to precipitated phosphate. The action of dissolved Peruvian guano was better than that of the crude guano, both as regards grain and straw.

Cosmos les Mondes.
Tome v., No. 10, July 7, 1883.

This number contains no chemical matter.

No. 11, July 14, 1883.

Protective Coating for Glass.—M. Schaal proposes the following process for the protection of retorts and other apparatus of glass exposed to high temperatures. He makes a mixture of kieselguhr (infusorial earth) and of soluble sodium silicate. This mass is applied as a soft paste, but not too liquid, so as to form a coating of 5 to 10 m.m. in thickness. The articles are then dried slowly.

MISCELLANEOUS.

Fast Red or Rocellin.—"Aequum et Bonum" is in error by stating that the Expert appointed by the Court in Badische Aniline and Soda Fabrik *versus* Levinstein made three sulphonations of *a*-naphthylamine, viz., one with 80 per cent, one with 30 per cent, and one with 10 per cent of fuming anhydrous sulphuric acid. The fact is that, although the Plaintiffs alleged that Defendant infringed the third process of which the sulphonation of naphthylamine is an essential part, the Court instructed the Expert to endeavour to sulphonate oxy-azo-naphthalene, and the Report of the Expert has reference only to the sulphonation of oxy-azo-naphthalene, which sulphonation is described in the first process of the Patent. There is some other passage in "Aequum et Bonum's" statement which is not quite correct, but as this case is not yet finally disposed of, it may be preferable to abstain from further comments.

ST. PAUL'S SCHOOL.—An EXAMINATION for FILLING UP about TWENTY VACANCIES on the FOUNDATION will be held on the 4th September, 1883.
For information apply to the Clerk to the Governors, Mercers' Hall, E.C.; or to the School Secretary, St. Paul's Churchyard, E.C.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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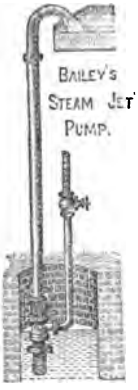

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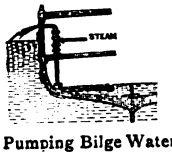

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1238.

ON THE REDUCTION OF POTASSIUM FERRIDCYANIDE BY POTASSIUM CYANIDE.

By C. L. BLOXAM.

CRYSTALLISED KCN (containing but little K_2CO_3) was dissolved in water, the solution heated in a retort, and potassium ferridcyanide added. The green colour of the latter changed to yellow, and the distillate contained much hydrocyanic acid and ammonium carbonate, the latter increasing in quantity towards the end of the distillation.

A small quantity of the cyanide effected the reduction of a large quantity of the ferridcyanide. On cooling, the solution deposited abundant crystals of potassium ferrocyanide. The mother-liquor was nearly neutral when the reaction was complete, and contained only minute quantities of cyanate and formate of potassium.

The principal reaction would appear to be—

$$2K_3FeC_6N_6+2KCN+2H_2O=$$
$$=2K_4FeC_6N_6+HCN+NH_3+CO_2.$$

This may be represented as taking place in three stages:—

(1.) $2K_3FeCy_6+2KCN=2K_4FeCy_6+2CN.$
(2.) $2CN+H_2O=HCN+HCNO.$
(3.) $HCNO+H_2O=NH_3+CO_2.$

When some of the same sample of KCN was distilled with water alone much HCN was found in the distillate, and some NH_3, but no CO_2. The liquid in the retort, even after repeated distillation with water, contained much undecomposed cyanide, together with potassium hydrate, potassium carbonate, and a little formate.

King's College, London.

ON SOME REACTIONS OF THE CYANIDE, FERROCYANIDE, AND FERRIDCYANIDE OF SILVER.

By C. L. BLOXAM.

IT is stated in the Second Supplement of Watts's "Dictionary" (p. 414), on the authority of Weith, that silver ferrocyanide, when boiled with aqueous ammonia, is completely decomposed, yielding ferrous oxide, silver cyanide, and ammonium cyanide. On making the experiment, I found that metallic silver was deposited on the sides of the test-tube, which led me to examine the reaction. When the well-washed snow-white precipitate formed by silver nitrate with potassium ferrocyanide is shaken with moderately strong ammonia, it forms an opalescent liquid which passes through a filter. When heated, it becomes of a brownish grey colour, and deposits a thin film of dead silver on the sides of the tube.

The grey precipitate was well washed, and a portion of it was treated with hot dilute nitric acid, which evolved nitrous fumes, and gave a solution containing silver nitrate and ferric nitrate, leaving a red residue of ferric oxide mixed with a little silver ferridcyanide.

Another portion of the grey precipitate was digested with ammonium sulphide, but no sulphocyanide was found, proving that no silver cyanide had remained undissolved by the ammonia. A third portion was treated with hydrochloric acid, which gave a solution containing both ferric and ferrous chlorides.

The ammoniacal filtrate, when neutralised with nitric acid, gave a copious precipitate of silver cyanide, and the filtrate from this contained much ammonium cyanide. It appears, therefore, that, in addition to the reaction given by Weith, viz.—

$$Ag_4FeCy_6+2NH_3+H_2O=4AgCy+2NH_4Cy+FeO.$$

Another reaction occurs, probably represented by the equation—

$$2Ag_4FeCy_6+6NH_3+3H_2O=$$
$$=6AgCy+6NH_4Cy+Fe_2O_3+Ag_2.$$

Action of Potash on Silver Ferrocyanide.—A strong solution of potash, acting in the cold upon silver ferrocyanide converts it into a very heavy brown precipitate in a colourless supernatant liquid which deposits a little metallic silver when heated, and stains paper brown, apparently by the deposition of silver. It contains a trace of potassium cyanide, but no ferro- or ferridcyanide. The brown precipitate contained metallic silver mixed with silver ferridcyanide and ferrocyanide. A part of the silver ferrocyanide appears to be converted into ferridcyanide, with separation of silver, $2Ag_4FeCy_6=2Ag_3FeCy_6+Ag_2$. The ferridcyanide thus formed, then enters into combination with the unchanged ferrocyanide, forming a compound which is not decomposed by cold potash, and does not yield its silver ferridcyanide to warm ammonia.

When boiled with potash, the silver ferrocyanide yields a solution containing silver cyanide and potassium cyanide and a black residue of ferrous and ferric oxides and silver; probably—

$$3Ag_4FeCy_6+8KHO=$$
$$=8KCy+10AgCy+FeO+Fe_2O_3+Ag_2+4H_2O$$

Action of Potash on Silver Ferridcyanide.—The well washed brown-red silver ferridcyanide precipitated by silver nitrate and potassium ferridcyanide, when treated with potash in the cold, became black, yielding silver oxide and potassium ferridcyanide which dissolved. On boiling, the black precipitate changed to a pink colour, and on continuing to boil this again became black.

The formation of the pink precipitate was attended by evolution of ammonia.

The pink precipitate contained a compound of silver cyanide with silver ferridcyanide, which was insoluble in ammonia, together with silver ferrocyanide, silver cyanide, and ferric oxide. The filtrate from the pink precipitate contained much potassium cyanide and silver ferrocyanide, with a little silver cyanide and potassium formate. The black precipitate finally obtained consisted of metallic silver and ferric oxide.

The filtrate from the black precipitate contained much potassium cyanide and silver ferrocyanide, together with silver cyanide and a little silver ferridcyanide.

As it seemed probable that the pink precipitate was a result of a reaction between the potassium ferridcyanide and the silver oxide formed in the cold, a quantity of well-washed precipitated silver oxide was boiled with solution of potassium ferridcyanide, when the same pink precipitate was produced, with evolution of ammonia.

On continuing the ebullition, the pink precipitate became black as before.

The first reaction is probably—

$$2K_3FeCy_6+3Ag_2O=6KCy+6AgCy+Fe_2O_3.$$

The AgCy then combines with some of the undecomposed silver ferridcyanide to form a more stable compound.

It was found that when silver cyanide and silver ferridcyanide are dissolved in ammonia, and the solutions boiled together, a buff-coloured precipitate is obtained which behaved like that obtained in the above experiment.

The potassium cyanide then acts upon the undecomposed silver ferridcyanide and reduces it to silver ferrocyanide.

This reaction was proved by direct experiment—

$$4Ag_3FeCy_6+4KCN+4H_2O=$$
$$3Ag_4FeCy_6+K_4FeCy_6+2HCN+2CO_2+2NH_3.$$

The final change of the precipitate to black is due to reduction of silver.

When precipitated, silver oxide and silver ferrocyanide are boiled together with water, the colour changes from brown to black, and silver cyanide, silver ferridcyanide, and metallic silver are formed—

$$2Ag_4FeCy_6+Ag_2O=Ag_3FeCy_6+6AgCy+Ag+FeO.$$

If silver ferridcyanide is boiled with silver oxide, there is no blackening, but formation of a pink precipitate containing the compound of silver cyanide and ferridcyanide, together with free silver cyanide (soluble in ammonia) and ferric oxide :—$2Ag_3FeCy_6+3Ag_2O=12AgCy+Fe_2O_3$.

King's College, London.

ON SAMARIUM AND ITS COMPOUNDS.

By Prof. P. T. CLEVE, Hon. Member of the Chemical Society.

Introduction.

IN the year 1878 Delafontaine found, on examining impure didymia, extracted from samarskite, some new absorption-bands, which did not belong to didymium but to an unknown element of higher atomic weight. He named this metal *decipium*. Some time later Lecoq de Boisbaudran found also in the fractions, rich in didymia, which were extracted from samarskite, a new oxide, distinguished by its absorption-spectrum and by peculiar spark-lines. The oxide was thrown down with ammonia before that of didymium. He called the metallic radical *Samarium*, and described more exactly than Delafontaine its absorption-spectrum. In March, 1880, Delafontaine published in the *Bibliothèque universelle de Genève* a paper "On the Atomic Weight and the Compounds of Decipium." The atomic weight was found to be 114, if the oxide be—

$$RO\ (=171 \text{ if } R_2O_3).$$

The salts were colourless and the sulphate less soluble than the sulphate of didymium. Shortly afterwards Marignac published his researches on the earths which in the samarskite accompany terbia, and found an oxide, named Yβ, distinguished by its yellow salts, its spectrum of absorption agreeing with that of samarium. The atomic weight of the metal was found, as a maximum 99·6, if the oxide be RO (=179·4 if R_2O_3), thus differing widely from the figures given by Delafontaine. The latter has more recently found that the decipia of 1878 could be split up into an oxide without absorption-spectrum, for whose radical, of the atomic weight—

$$117\ (\text{or } 171 \text{ if } R_2O_3)$$

he reserved the name of decipium, and another oxide with the spectrum described by Lecoq de Boisbaudran. He adopted the name of samarium for the metal which has as a maximum the atomic weight 101 (or 151·5 if R_2O_3).

Method of Extraction.

The raw material which I used for extracting the oxide of samarium consisted principally of a mixture of almost all the rare oxides of the earth-metals, which were obtained from Dr. Paijkull, in Stockholm, and said to be derived from orthite found at Arendal in Norway. As the matter, about 10 kilos., contained almost 10—12 per cent thorina, it may be assumed that a considerable quantity of thorite may have been mistaken for orthite. The mixture of earths was mixed with nitric acid and heated in china basins till it began to give off red vapours. After cooling, the mass was treated with water, which left undissolved a large quantity of basic nitrates, principally of cerium and thorium. These basic nitrates were insoluble in saline liquids, but dissolved in pure water, forming opalescent solutions. They were separated by decantation and filtering, and washed as long as the liquid went clear through the filter. The basic salts were mixed with strong sulphuric acid, and the solution of the sulphates in cold water was precipitated with large quantities of hot water, by which operation most of the cerium was separated as basic sulphate.

The solution was then precipitated with caustic soda, and the hydrate, principally of thorium, dissolved in diluted sulphuric acid. On evaporating off the solution, large and bulky masses of thorium sulphate were obtained. The oxides which remained in the mother-liquors were transformed into nitrates and added to the solution of nitrates obtained by the first operation. These nitrates were evaporated, and the residuum was heated in platinum basins till it began to give off red vapours. On treating the heated mass with water, a solution free from cerium and thorium was obtained.

By this treatment also considerable quantities of the nitrates of the more positive metals, yttrium, didymium, &c., were decomposed, and separated together with the thorium and cerium, and to complete the separation, the basic nitrates were once again and carefully treated in the same manner. The solutions free from the oxides of cerium and thorium, or containing only small traces of these oxides, were precipitated with potassium sulphate with the view of separating the cerium- and yttrium oxides, of which the former were (incompletely) precipitated, and the latter (incompletely) retained in the solution.

The yttrium earths (about 700 grms.) were transformed into nitrates and subjected to the usual melting-process, for separation of erbia from yttria, terbia, and didymia, which offer greater resistance to the action of heat. From the basic nitrates first obtained a small quantity (about 1·5 grms.) of scandium oxide was separated.* They contained also a very small quantity of thulium, some erbia and ytterbia, and a considerable portion of holmia. The fractions containing yttria and didymia were saturated with potassium sulphate, and this precipitate was added to the similar precipitate formerly obtained. These difficultly soluble double sulphates were decomposed with boiling potash-ley, and the hydrates dissolved in diluted sulphuric acid were again treated with potassium sulphate. In the solution there then remained considerable quantities of terbia (about 200 grms. impure earth). The precipitate was converted into nitrate and its solution evaporated. The residue was then heated to partial decomposition in order to separate the last remaining traces of thorium and cerium.

The soluble nitrates thus obtained, which contained principally didymium and lanthanum, but also samarium, terbium, yttrium, &c., were mixed with impure didymium, extracted from various minerals, as cerite, gadolinite, keilhauite, &c., and then subjected to partial precipitation with cold dilute ammonia. The last fractions contained much lanthanum, which was separated partly by the Mosander method, and partly by precipitation with ammonia. No oxide intermediate between that of lanthanum and that of didymium could be obtained, although I sacrificed much time in searching for such an oxide. The first precipitations were repeatedly treated in the same manner with dilute ammonia. In this way I obtained several fractions containing both terbia and didymia (samarium, &c.). They were again treated several times with sulphate of potash.

The slightly soluble double sulphates were now decomposed, and the solution of the hydrates in nitric acid was repeatedly precipitated with ammonia. I obtained finally the following fractions :—

1 : about 67 grms. light-coloured oxides, whose solution was very little coloured, but showed, besides the spectrum of samarium, also the spectrum of didymium. Atomic weight R = 149—159.

* No scandium could be obtained from the precipitate with sulphate of potassium.

2 : about 4 grms.	oxide ;	At. wt. R = 148	
3 : „ 1·7	„	„	= 146·2
4 : „ 6	„	„	= 143·7
5 : „ 150	„	„	= 142·7
6 : „ 29	„	„	= 142·3

The sixth fraction was subjected to partial precipitation with ammonia, but the atomic weight of the four fractions thus obtained was still found to be 142·3.

This is a proof of the correctness of my latest determinations of the atomic weight of didymium, which gave the same numbers. No lanthanum was present in these fractions. As the fractions intermediate between the pure or almost pure didymium and the samarium are only trifling, there is very little probability of finding any unknown element intermediate between samarium and didymium.

The 67 grms. of earths containing the principal quantity of samarium were now subjected to the same treatment with dilute ammonia, until the absorption-spectrum of didymium was completely eliminated. The oxides freed from didymium were far from pure samarium oxide, and I was therefore obliged to precipitate their solutions with potassium sulphate.

At first I several times used solutions with 2 per cent oxide, and later with only ½ per cent. Terbia and other oxides (Yα, decipium) were thus eliminated together with much samarium oxide. The treatment with potassium sulphate was continued until the oxide, which remained in the solution, had the same molecular weight as the oxide thrown down, or R''' = 150.

A considerable quantity of samaria was separated at the same time as terbia and Yα, for which reason I was obliged to subject these oxides to the same treatment, whereby I finally obtained the fractions used for the atomic weight determinations A and B, A being oxide left in the solution, and B precipitated as double sulphate.

I have described this method, as long experience has has convinced me that the coarse separation of all the rare earths may be most conveniently effected thereby.

Atomic Weight of Samarium.

The samarium oxide, obtained as above described, was purified by treatment with sulphuretted hydrogen, repeated precipitation of the solution with ammonia, and finally in acid solution with pure oxalic acid. The oxide obtained by calcination of the oxalate was dissolved in pure nitric acid, and by precipitation with freshly distilled ammonia, divided into four fractions, I., II., III., IV. These were transformed into oxalate and oxide. The four fractions thus obtained were subjected to atomic weight determinations in the usual way, by solution in nitric acid, addition of sulphuric acid, and estimation of the sulphates. The fractions A and B were obtained, as stated in the foregoing section, from the samarium oxide which remained in the solution of potassium sulphate.

The atomic weight determinations gave the following results :—

	Oxide Sm_2O_3.	Sulphate.	Per cent of oxide in the sulphate.	At.wt.(SO_3=80.)
I.	1·6735	2·8278	59·180	149·975
II.	1·9706	3·3301	59·175	149·940
III.	1·1122	1·8787	59·201	150·120
IV.	1·0634	1·7966	59·190	150·045
A.	0·8547	1·4440	59·190	150·045
B.	0·7447	1·2583	59·183	150·000

As a mean of these six closely agreeing experiments, the atomic weight is 150·021, or in round numbers 150. In the calculation I have supposed the oxide to be Sm_2O_3, which follows beyond doubt from its chemical properties, that is from the composition of the chloroplatinate, of the samarium and ammonium sulphate, and of the selenite. Whether samarium gives other oxides besides Sm_2O_3 is a point which I have not yet determined. As to its position in the system of Mendelejeff, I think it may most probably be placed in the 8th group, on the 8th line, where there is a gap for a group of unknown elements.

Spectrum of Samarium.

The salts of samarium are distinguished by a peculiar spectrum, composed of several bands, among which four in the blue part of the spectrum are most characteristic. The absorption-spectrum has been examined by Lecoq de Boisbaudran and by Thalén. The latter used a solution of the nitrate prepared by myself.

Both found about the same bands, viz :—

	Wave-length according to	
Numbers.	Lecoq de Boisbaudran.	Thalen.
I.	559	556 —559
II.	551—500	501·5—497
III.	489 (indistinct)	—
IV.	486—474	486 —472 strong
V.	464—463	466 —460 strong
VI.	—	445 —437 not strong
VII.	417	418·5—415
VIII.	400·75	409 (limit not visible).

The intensity of the absorption is not very great, so that the absence of these bands in didymium salts cannot be regarded as a sure test for the absence of samarium.

The spark-spectrum of samarium has been examined by Professor Thalén, who will soon publish his results. He has found about 150 lines scattered over the whole spectrum, except the red part. They are all of little intensity. Many among these lines were mapped by him in connection with his examination of the spectrum of didymium in the year 1873 (*Kongl. Svenska Vetensk.-Akad. Handlingar*, t. xii., No. 4). The didymia, which I regarded at that time as pure, was thus a mixture of didymia and samaria, which is also apparent from the atomic weight 147, instead of 142·3.

Compounds of Samarium.

Oxide of Samarium, Sm_2O_3, is a white powder, with a scarcely perceptible yellowish tint. If yellow it contains terbia. It is easily soluble in acids, and gives with them salts whose solutions are intensely yellow. The crystallised salts are topaz-coloured, but in the state of powder they are white, with a yellowish tint.

The *hydroxide* is a gelatinous, white, or indistinctly yellowish precipitate, insoluble in alkalies. It is a stronger basic than yttria, but not so strong as didymia.

Chloride of Samarium, $SmCl_3+6H_2O$, crystallises in large tabular crystals, which are deliquescent. Pressed between paper, as were all the following salts, it gave by analysis the following results :—

0·5708 grm. gave 0·6647 grm. AgCl.

0·7375 grm. gave 0·3513 Sm_2O_3. precipitated as oxalate.

In per cent.	Calc.	Found.
Sm	41·15	41·06
Cl	29·22	28·79

Chloroplatinate of Samarium, $SmCl_3,PtCl_4+10\frac{1}{2}H_2O$, crystallises over sulphuric acid in orange-coloured prisms, which are deliquescent, and lose at 110° 8·71 per cent H_2O (4 mols. = 9·20).

0·5775 grm. gave 0·3611 grm. $Sm_2(SO_4)_3+Pt$, which left on washing with water 0·1402 grm. Pt.

	Calc.	Found.
Pt	24·92	24·22
Pt + Sm_2SO_4	62·49	62·53

Platinocyanate of Samarium,—

$$2Sm(CN)_3+3Pt(CN)_2+18H_2O,$$

obtained by double decomposition of the barium salt with the sulphate, crystallises in well-developed yellow prisms, which reflect blue light. It is unchangeable in the air, and loses at 110° 16·33 per cent. H_2O (14 mols. = 16·57).

0·6963 grm. gave 0·5396 grm. $Sm_2{}^3SO_4+Pt$, which left by washing with water 0 2694 grm. Pt.

	Calc.	Found.
Pt..	38·46	38·69
$Pt+Sm_2{}^3SO_4$ ..	77·12	77·49

Nitrate of Samarium, $Sm(NO_3)_3+6H_2O$, crystallises in easily soluble prisms of pale yellowish colour.

1·0969 grms. left by ignition 0·4274 grm. Sm_2O_3.

	Calc.	Found.
Sm_2O_3..	39·19	38·96

Acetate of Samarium, $Sm(C_2H_3O_2)_3+4H_2O$, forms short, well-developed prisms, moderately soluble in water.

0 7886 grm. lost by 110° 0·1393 grm. H_2O, and gave by ignition 0·3444 grm. Sm_2O_3.

0·8688 grm. lost 0·1546 grm. H_2O, and gave 0·3802 grm. Sm_2O_3.

	Calc.	Found
Sm_2O_3	43·61	43·67—43·76
H_2O	18·05	17·66—17·79

Sulphate of Samarium, $Sm_2(SO_4)_3+8H_2O$, obtained by evaporating on the water-bath a solution of the nitrate mixed with sulphuric acid, forms well-developed brilliant crystals, much less soluble in water than sulphate of didymium.

0·8966 grm. lost by careful heating 0·1763 grm. H_2O.

0·8240 grm. lost 0·1620 grm. H_2O.

Both experiments gave 19·66 per cent H_2O instead of 19·67.

Selenate of Samarium, $Sm_2(SeO_4)_3+8H_2O$, is easily soluble in water. but in other respects resembles the sulphate.

0·9881 grm. lost by careful heating over the open fire, 0·1642 grm., and left by heating to white-red, 0·3951 grm. Sm_2O_3.

	Calc.	Found.
Sm_2O_3	39·86	39 99
H_2O	16 49	16·62

Sulphate of Samarium and Potassium,—

$$2Sm_2(SO_4)_3+9K_2SO_4+3H_2O$$

was slowly deposited as a white powder, when acetate of samarium was added to an excess of sulphate of potassium. It is very little soluble in a saturated solution of sulphate of potash. It is difficult to state in figures the solubility, as it seems to be much dependent on the temperature and the more or less quantity of free acid present. I have generally found that 1 litre of the saturated solution contains about ½ grm. of samarium oxide.

1·2545 grms. lost by heating 0 0246 grm. H_2O (hygroscopic ?). The anhydrous salt was dissolved in water, acidulated with HCl, and precipitated with ammonia. The basic sulphate was again dissolved and precipitated. The solutions were evaporated, and gave 0·7229 grm. K_2SO_4. The oxide of samarium, precipitated as oxalate, amounted to 0·3157 grm.

	Calc.	Found
Sm_2O_3	24·87	25·17
K_2O	30·31	31·00
H_2O	1·93	1·96

I have before analysed a compound of didymium, having the same composition.

Sulphate of Samarium and Ammonium,—

$Sm_2(NH_4)_2(SO_4)_4+8H_2O$, or

$$Sm_2(SO_4)_3(NH_4)_2SO_4+8H_2O,$$

crystallises from the mixed solutions of the simple sulphates containing excess of ammonium sulphate, in small tabular crystals.

0·7168 grm. lost by 110° 0·0935 grm. H_2O, and left by heating to white-red, 0·2888 grm. Sm_2O_3.

	Calc.	Found.
Sm_2O_3	40·28	40·29
H_2O(⅛)	12·50	13·04

Selenite of Samarium, $Sm_2O_3.4SeO_2+5H_2O$, was thrown down by addition of selenious acid to the solution of the acetate as a bulky precipitate, which was very soon transformed into microscopic needles.

0·8312 grm. lost by 110° 0·0523 grm. H_2O, and gave 0·2935 grm. Se, and 0·3233 grm. Sm_2O_3, precipitated as oxalate.

0 8910 grm. gave 0·0560 H_2O, 0·3175 grm. Se, and 0·3465 grm. Sm_2O_3.

	Calc.	Found.
Sm_2O_3	39·46	38·90—38·89
SeO_2	50·34	49·61—50·07
H_2O (⅛)	6·12	6·29— 6·28

Oxalate of Samarium, $Sm_2(C_2O_4)_3+10H_2O$, is a white or pale-yellowish crystalline precipitate. From concentrated solutions it is first thrown down as a viscid, yellowish mass, which soon hardens.

1·0029 grm. lost by 110° 0·1516 grm. H_2O, and gave by ignition 0·4638 grm. Sm_2O_3.

	Calc.	Found.
Sm_2O_3..	46·77	46·25
H_2O (10%)	14·52	15 12

The salts of samarium agree closely in composition with the didymium salts; and of all elements, samarium is most nearly related to didymium, less closely to the yttria metals, the platinocyanates of the latter being wholly different from the samarium salt, which resembles the corresponding salts of cerium, lanthanum, and didymium.—*Journal of the Chemical Society*, August, 1883.

TRANSMISSION OF GASES THROUGH FLUIDS OF DIFFERENT DENSITIES.

A LECTURE EXPERIMENT.

BY C. GILBERT WHEELER.

IF in a given acidified and nearly saturated solution of a salt (I have generally used ferrous sulphate and added a small quantity of sulphuric acid) a piece of zinc is placed, and this solution carefully overlaid with common water, the bubbles of hydrogen appear to meet with considerable resistance at the zone of contact between the two liquids, and from one-third to one half are reflected downward and to one side. Finally, however, they are again induced by their relative levity to rise; and now scattered, and at a part of the vessel remote from their first ascent, pass through the upper zone and escape into the air.

This phenomenon is again exhibited if upon the second or upper stratum a third liquid is superimposed having a density less than that of water. The appearances at this second zone are, however, not quite as marked as at the first.

What is the cause of this apparent reflection of the hydrogen bubbles in passing from a denser into a rarer medium? I confess that at present a wholly satisfactory explanation does not occur to me.

Certainly it does not appear reasonable that the circumstance of their meeting with less resistance on entering the rarer medium should occasion a reflection, though by virtue of the reduced difference between the densities of the aër form body in this second stratum and its enveloping fluid it is conceivable why, perhaps, a less rapid upward movement should result. Is not, however, this influence in favour of a less rapid movement more than compensated for by the diminished resistance of this second medium? Be this as it may, it still cannot explain, I think, why there is a positive reflection of a large part of the bubbles. It might explain a mere retarding in their movement.

In explanation of the above phenomenon it may also be assumed that the bubbles of gas as they rise from the

saline liquid into the water above carry with them their envelope, *i.e*, the thin film of solution encircling them. When, therefore, they enter the upper liquid they are too much weighted down to pass at once through the latter, and are therefore detained for an instant. In the meanwhile they are caught by the descending current of the solution, and are for a time carried sidewards and downwards. This downward current is caused as a result of the upward current formed by the rapid ascent of the hydrogen set free by the zinc. I am devising experiments to settle this, if possible, and hope soon to report.—*American Chemical Journal.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF WATER SUPPLIED TO LONDON DURING THE YEAR 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

London, May 30th, 1883.

SIR,—We beg to submit, for the information of the Local Government Board, a statement and discussion of the general results of our examination, made at the expense of the Water Companies of the 2110 samples of water collected by us during the year 1882, from the mains of the seven London Companies taking their supply from the Thames and Lea.

Of these 2110 samples of water, 299 were taken from the mains of the New River Company, 303 from the mains of the East London Company, 300 from the mains of the Chelsea Company, 302 from the mains of the West Middlesex Company, 304 from the mains of the Lambeth company, 301 from the mains of the Grand Junction Company, and 301 from the mains of the Southwark and Vauxhall Company.

Since we commenced the work of our monthly Reports, in December 1880, we have examined and reported on 4291 samples of water.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

To the Secretary of the Local Government Board.

Colour of the Water.

We have continued to employ the colour-meter, described by us in previous Reports, for the purpose of registering the daily colour of the various samples of water submitted by us to examination. Without for a moment suggesting that it is incapable of further improvement, a large experience in its use warrants us in affirming that it affords far more accurate results than the rough methods heretofore and still made use of by chemists in general.

In Tables I. to VII. will be found recorded the results of our daily examinations of the colour presented by the water supplied by the several Companies. We have further expressed these results diagrammatically in wave diagrams which will be found at the end of the Report.

Clearness.

For want of better, we continue to employ the arbitrary terms of "turbid," "slightly turbid," and "very slightly turbid;" giving to these terms the special signification explained in previous reports.

Of 299 samples collected from the mains of the New River Company, the whole without a single exception were clear, bright, and well filtered.

Of 303 samples from the mains of the East London Company, six were fonnd to be "very slightly turbid," and two "slightly turbid." The remaining 297 were clear, bright, and well filtered.

Of 300 samples from the mains of the Chelsea Company, one was recorded as "turbid," one as "slightly turbid," and one as "very slightly turbid," the remaining 297 samples being clear, bright, and well filtered.

Of 302 samples from the mains of the West Middlesex Company, one was recorded as "slightly turbid," and two as "very slightlty turbid," the remaining 299 samples being clear, bright, and well filtered.

Of 304 samples from the mains of the Lambeth Company, eleven were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 296 samples were clear, bright, and well filtered.

Of 301 samples from the mains of the Grand Junction Company, ten were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 289 samples were clear, bright, and well filtered.

Of 302 samples from the mains of the Southwark and Vauxhall Company, ten were recorded as "very slightly turbid," and two as "slightly turbid." The remaining 294 samples were clear, bright, and well filtered.

Summarising these results, we found 40 samples "very slightly turbid," 10 "slightly turbid," and 1 "turbid," leaving 2059 samples entirely free (so far as unaided vision could determine) free from suspended matters.

Of the total 51 samples not entirely free from suspended matter 35 were coincident with and dependent on the occurrence of periods of violent rain-fall, namely 15 samples in March-April, 7 samples in July, and 13 samples in October.

Free Oxygen.

In Tables IX. to XV. we have recorded, in cubic inches per gallon, the quantity of free oxygen in the whole of the samples examined. The mean result of the two hundred or so determinations, made by us every month, are set forth in the tabular statement given below; from which it appears that the quantity of free oxygen in the water ranges from 1¾ to 2¼ cubic inches per gallon, the quantity varying inversely with the temperature, in accordance with the law of the variation of gas-solubility with temperature. Practically, the water has been found to be throughout the year fully aërated or oxygenated. To the series of experiments on this subject, at present carried out exclusively by ourselves, and to the general result obtained, we attach considerable importance, as demonstrating the high character of the metropolitan water in respect to its freedom from putrescent matter.

	Oxygen in cubic inches per Gallon.	Mean temperature of air.
January	2·16	40·2
February	2·25	41·1
March	2·18	46·1
April	2·09	47·9
May	1·93	53·5
June	1·89	56·3
July	1·78	60·2
August	1·74	60·3
September.. ..	1·85	53·8
October	1·96	51·2
November.. ..	2·12	41·3
December.. ..	2·21	40·3

Ammonia and Organic Matter.

In Table XVI. will be found recorded the quantities of free or saline ammonia present in the 272 samples of water examined. It is noteworthy that the 1-500th of a grain of ammonia per gallon was the maximum amount found, and this on 12 occasions only. On 68 occasions

the 10000th of a grain per gallon was recorded; whilst 192 examinations revealed no appreciable trace of ammonia whatsoever.

The actual organic matter present has been estimated by determining the oxygen required to oxidise the organic matter, and by combustion. In estimating the oxygen required, we have adopted the method described in detail by one of our number in the *Journal of the Chemical Society* (vol. xxxv., p. 46, 1879); while in the combustion process, we have followed the lines laid down by Frankland and Armstrong. The oxygen required to oxidise the organic matter has been estimated in 7 samples daily, viz., a sample from each Company's supply, and our results are summarised and arranged in Tables XVII. to XXIII. The organic carbon and nitrogen have been estimated in one sample daily, and our results are given in Table XXIV. We have in this Table given also, in a companion column, the quantities of oxygen necessary to oxidise the organic matter in the same samples.

In our last year's Report we drew attention to some broad facts, which an examination of the curves, plotted from the Tables, brought out very prominently. These were the close parallelism which existed between the amount of organic carbon, as determined by the combustion process, and the amount of oxygen required to oxidise the organic matter, as determined by permanganate. We showed that, despite some some irregularities the two quantities sank together as the summer came on, and rose again towards the winter. Indeed this similarity extended to the minor fluctuations, and these were so concordant as to lead us to suggest that, for practical purposes of water analysis, the oxygen process afforded indirectly a trustworthy measure of the amount of organic carbon present in a water. This relationship, showing such a close agreement in results between the combustion and the oxygen processes of carbon determination, was not seen to extend so fully to the colorimetric process. But though the connection between the greater or less colour-tint of the waters and the organic carbon was not so obvious, still we drew attention to the fact that the broad fluctuations, corresponding to the fall in summer and rise in winter, were well marked, while some of the more decided oscillations were likewise reproduced.

We have now the gratification of being able to show that the connection between the brown colour of the Metropolitan waters and the amount of organic carbon they contain, which was suspected last year, proves to be strikingly close.

The same facts have presented themselves this year as last year, but, more fortunate than before, we are able to show their real import. The scale on which last year's curve was plotted was too small. In the present curves we have merely lengthened the ordinates representing the brown colouration, so as to make the colour scale comparable with the scales of the combustiou and permanganate results, and the suspicion of last year now becomes a certainity.

The curves representing the "organic carbon" and "oxygen required" are on the same scale as before, but the scale of the "brown colour" curve has been enlarged five times; whilst the blue colour, proving a constant quantity in all the waters, has been suppressed as unnecessary.

The three curves are now seen to correspond so closely as to force on us the conviction that the same cause is at work in all three instances. The amount of organic carbon present in the water is the active ingredient in each case. In the upper curve it reveals itself by its power of reducing permanganate of potash. In the middle curve it registers the number of parts of carbon present in 100,000 parts of water. In the lower curve the organic carbon actually shows itself to the eye by darkening the water, and so enabling itself to be measured by a mere inspection in the colorimeter.

Taking the amount of organic carbon in a water to be a measure of the organic matter present, these curves show that, at all events in the case of the waters supplied to the metropolis, a very fair estimate of their purity in respect to organic matter may be made by mere optical examination.

The relationship thus exhibited goes far to establish the usefulness of the colorimetric mode of examination introduced and employed by ourselves, and its value as an improvement on the rougher methods still in common use.

Nitrogen (as Nitrates and Nitrites) and Chlorine.

These have been estimated in daily samples of the waters, and the results are stated in Tables XXV. and XXVI. The quantity of nitrogen, in the form of nitrate or nitrite, ranges from about one and a quarter tenths of a grain to two and a quarter tenths of a grain per gallon, the quantity being on the average somewhat lower in the summer and autumn than in the winter and spring quarters. The variation with season in the quantity of chlorine or common salt present in the waters is not very obvious. The quantity of chlorine amounts throughout the year to either close upon, or a little over, one-tenth of a grain per gallon.

Hardness.

The degree of hardness has been estimated in a daily sample of the water, and our results are given in Table XXVII.

With regard to the mineral matter held in solution in the waters, it consists mainly of the carbonates of the alkaline earths, with a small quantity of sulphates, nitrates, and chlorides. No one suggests that the presence of these salts in the water is prejudicial to health; while there is, on the contrary, some reason to believe that they are actually useful to the animal economy, as one means of supplying constituents required for the organism.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

NITROGEN.

THE atomic weight of nitrogen has been determined from the density of the gas, from the ratio between ammonium chloride and silver, and from the composition of certain nitrates.

Upon the density of nitrogen a great many experiments have been made. In early times this constant was determined by Biot and Arago, Thomson, Dulong and Berzelius, Lavoisier, and others. But all of these investigations may be disregarded as of insufficient accuracy; and, as in the case of oxygen, we need consider only the results obtained by Dumas and Boussingault and by Regnault.

Taking air as unity, Dumas and Boussingault† found the density of nitrogen to be—

0·970
0·972
0·974

Mean $0·972 \pm 0·00078$

For hydrogen, as was seen in our discussion on the atomic weight of oxygen, the same investigators found a mean of $0·0693 \pm 0·00013$. Upon combining this with the above nitrogen mean, we find for the atomic weight of the latter element, $N = 14·026 \pm 0·0295$.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Comptes Rendus*, 12, 1005. 1841.

By Regnault* much closer work was done. He found the density of nitrogen to be as follows:—

0·97148
0·97148
0·97154
0·97155
0·97108
0·97108

Mean 0·97137 ± 0·000062

For hydrogen, Regnault's mean value is 0·069263 ± 0·000019. Hence, combining as before; N = 14·0244 ± 0·0039.†

The value found by combining both series of experiments is N = 14·0244 ± 0·0039.

In discussing the more purely chemical ratios for establishing the atomic weight of nitrogen, we may ignore, for the present, the researches of Berzelius, of Anderson, and of Svanberg. These chemists experimented chiefly upon lead nitrate, and their work is consequently now of greater value for fixing the atomic weight of lead. Their results will be duly considered in the proper connection further on.

The ratio between ammonium chloride and silver has been determined by Pelouze, by Marignac, and by Stas. The method of working is essentially that adopted in the similar experiments with the chlorides of sodium and potassium.

For the ammonium chloride equivalent to 100 parts of silver, Pelouze‡ found:—

49·556
49·517

Mean 49·5365 ± 0·013

Marignac|| obtained the following results. The usual ratio for 100 parts of silver is given also:—

8·063 grm.	Ag = 3·992 grm.	NH_4Cl.	49·510
9·402	,,	4·656	,,	49·521
10·339	,,	5·120	,,	49·521
12·497	,,	6·191	,,	49·540
11·337	,,	5·617	,,	49·546
11·307	,	5·595	,,	49·483
4·326	,	2·143	,,	49·538

Mean 49·523 ± 0·0055

But neither of these series can for a moment compare with that of Stas.§ He used from 12·5 to 80 grms. of silver in each experiment, reduced his weighings to a vacuum standard, and adopted a great variety of precautions to insure accuracy. He found for every 100 parts of silver the following quantities of NH_4Cl:—

49·600
49·599
49·597
49·598
49·597
49·593
49·597
49·5974
49·602
49·597
49·598
49·592

Mean 49·5973 ± 0·0005

Now, combining these three series we get:—

Pelouze	49·5365	± 0·013
Marignac	49·523	0·0055
Stas	49·5973	0·0005
General mean	49·597	± 0·0005

The quantity of silver nitrate which can be formed from a known weight of metallic silver has been determined by Penny, by Marignac, and by Stas. Penny* dissolved silver in nitric acid in a flask, evaporated to dryness without transfer, and weighed. One hundred parts of silver thus gave of nitrate:—

157·430
157·437
157·458
157·440
157·430
157·455

Mean 157·4417 ± 0·0033

Marignac's† results were as follows. In the third column they are reduced to the common standard of 100 parts of silver.

68·987 grm.	Ag gave	108·608	$AgNO_3$	157·433
57·844	,,	91·047	,,	157·401
66·436	,,	104·592	,,	157·433
70·340	,,	110·718	,,	157·404
200·000	,,	314 894	,,	157·447

Mean 157·4236 ± 0·0061

Stas,‡ employing from 77 to 405 grms. of silver in each experiment made two different series of determinations at two different times. The silver was dissolved with all the usual precautions against loss and against impurity, and the resulting nitrate was weighed, first after long drying without fusion just below its melting-point; and again, fused. Between the fused and the unfused salt there was in every case a slight difference in weight, the latter giving a maximum and the former a minimum value.

In Stas' first series there are eight experiments; but the seventh he himself rejects as inexact. The values obtained for the nitrate from 100 parts of silver are given below in two columns, representing the two conditions in which the salt was weighed. The general mean given at the end I have deduced from the means of the two columns considered separately:—

Unfused.	*Fused.*
157·492	157·474
157·510	157·481
157·485	157·477
157·476	157·471
157·478	157·470
157·471	157·463
157·488	157·469
Mean 157·4857	Mean 157·472

General mean 157·474 ± 0·0014

In the later series there are but two experiments as follows:—

Unfused.	*Fused.*
157·4964	157·488
157·4940	157·480
Mean 157·4952	Mean 157·484

General mean 157·486 ± 0·0003

Now to combine all four sets of results:—

* *Comptes Rendus*, 20, 975. 1845.
† Professor Le Conte, in his corrections of Regnault's calculatio ns, already cited in a foot note to the chapter on oxygen, finds for the density of nitrogen the value 0·971346. Hence N = 14·0225. This correction is very slight, but it should be considered in any future revision of the atomic weights.
‡ *Comptes Rendus*, 20, 1047. 1845.
|| "Berzelius's Lehrbuch," 5th edition, vol. iii., 1184, 1185.
§ "Aronstein's Translation," pp. 56-58.

* *Phil. Trans.*, 1839.
† "Berzelius's Lehrbuch," 5th edition. iii. pp. 1184, 1185.
‡ "Aronstein's Translation," pp. 305 and 315.

Penny	157·4417	± 0·0033
Marignac	157·4236	0·0061
Stas, 1st series	157·4740	0·0014
Stas, 2nd series	157·4860	0·0003
General mean	157·479	± 0·0003

For the direct ratio between silver nitrate and silver chloride there are two series of estimations. A weighed quantity of nitrate is easily converted into chloride, and the weight of the latter ascertained. In two experiments Turner* found of chloride from 100 parts of nitrate :—

84·357
84·389

Mean 84·373 ± 0·011

Penny† in five determinations, found the following percentages :—

84·370
84·388
84·377
84·367
84·370

Mean 84·3744 ± 0·0025

The general mean from both series is 84·3743 ± 0·0025.

(To be contined.)

NOTICES OF BOOKS.

Reports of Trials for Murder by Poisoning by Prussic Acid, Strychnia, Antimony, Arsenic, and Aconita. Including the Trials of Tawell, Palmer, Dove, Madeline Smith, Dr. Pritchard, Smethurst, and Lamson, with Chemical Introduction and Notes on the Poisons used. By G. Lathom Browne, of the Midland Circuit, Barrister at-Law, and C. G. Stewart, Senior Assistant in the Laboratory of St. Thomas's Hospital, Associate of the Royal College of Science, Dublin, and of the Society of Public Analysts. London : Stevens and Sons.

We have here a most interesting and important work, the joint product of a barrister and a chemist, and dealing with poisons and their administration both from a legal and a medico-chemical point of view. The discovery of poisons in the animal system and the detection of the guilty person are shown, not merely in theory, but as they have actually occurred in the most celebrated cases of the last half-century. The toxicologist, as he studies this volume finds himself brought face to face with the difficulty of proving to the satisfaction of a jury the presence of any given poison in the intestines, &c., of the supposed murdered person. He finds recorded the objections and the doubts which have been raised, and which, under similar circumstances, would be sure to recur, and he learns how to avoid or to overcome them.

In the first chapter our authors give a "chemical introduction." They give a notice of the manner of death and of the characteristic symptoms as giving a clue to the fact that poison has been taken, and secondly to the particular kind. They point out that in medical evidence on the individual poisons, those physiologically resembling the one concerned are always most heard of at the trial, and questions are asked whether some other cause may not have produced the same symptoms.

We find next an account of the vegetable bases, the processes for their separation, and their characteristic reactions. This part of the subject naturally leads to a consideration of the ptomaines or cadaveric alkaloids of Selmi, Gautier, &c. The existence of these bodies raises a fresh difficulty, and raises a new and plausible line of defence. It is here admitted that there is no general method known of distinguishing the cadaveric alkaloids, as a class, from the vegetable bases. But they add, very justly, that there is no ptomaine known which gives *all* the reactions of strychnine. Hence, if the chemist is asked—"Could any other substance produce these reactions ?" he can only answer, "I do not know of any." Amongst a number of general principles laid down at the end of this chapter, two especially deserve notice. It is said that unhealthy or improper food, or acute disease, may cause suspicious symptoms." Of this there have been very numerous instances. Death has followed, *e.g.*, after eating cheese, under symptoms which seemed to point decidedly to a mineral irritant ; yet, on careful analysis, no trace of arsenic, mercury, antimony, &c., could be detected.

The following seems to us to demand partial rectification :—"In experiments on animals, it may be objected that they are inconclusive as to man. This is not strictly true But if a *recent vomit* proves poisonous to an animal with the same symptoms as in the man, that is almost conclusive evidence." We should argue that difference of symptoms is not the slightest objection if the symptoms in either case are accurately known. Suppose that an alkaloid, *x*, produces in a man certain symptoms which we may call *a*, *b*, *c*, &c., but in a dog another set of symptoms, *l*, *m*, *n*, &c. If a man displays the symptoms *a*, *b*, *c*, and if the matter which he has vomited, or an extract from the contents of his stomach or liver, produce in a dog the symptoms *l*, *m*, *n*, the evidence is then altogether as conclusive as if the symptoms in the two cases were alike. Our authors, therefore, would have done well to omit the words "with the same symptoms as in the man," and to have used some more emphatic form of dissent than "This is not strictly true."

There is a caution which the authors seem to have overlooked. It is this : If a body has been exhumed after lying for some time in the grave, and if, *e.g.*, arsenic is found in the remains, it may be contended,—in fact, it has actually been done—that the poison has been absorbed after death from the surrounding soil, or from other bodies in the same grave. In such cases, therefore, it is well, when exhuming the body, to secure samples of the soil at different distances, and submit them to a quantitative examination for the same poison found in the body.

In the succeeding chapters the authors go on to report and discuss trials for poisoning with the best-known deadly drugs, beginning with prussic acid. Here we have, first, the once well-known case of John Tawell, who was tried at Aylesbury, in 1845, for the murder of his mistress, Sarah Hart. Among the principal points of this case was the puerile attempt made by counsel for the defence to show that the hydrocyanic acid found in the stomach of the deceased might have been derived from apple-pips ! The deceased woman had undoubtedly been eating apples, and their pips certainly contain a trace of hydrocyanic acid. But, according to an authority, it would be necessary to take the pips of from 18 to 135 lbs. of apples (according to quality) to furnish a poisonous dose of the acid. Further, few people, when eating apples, swallow the pips ; those which are swallowed escape mastication, and are voided unchanged. Hence it may truly be said "that of fruits an impossibly large quantity must be eaten to produce any considerable amount of hydrocyanic acid." Reference is made to the evidence of one Henry Thomas, a druggist's assistant, said to have been in communication with the prisoner's solicitor, who swore that "15 small apples gave 2½ grains of silver cyanide," equal to 0·46 of anhydrous hydrocyanic acid. This the authors pronounce "a fair sample of the erroneous and bewildering evidence that is frequently offered in courts of justice." But who is to blame if the evidence of unscientific men upon scientific questions is

* *Phil. Trans.*, 1833, 537.
† *Ibid.*, 1839.

offered, and made, as seems here to have been the case, the basis of a hypothesis? This point suggests a lesson to experts. If Mr. Cooper, the chemist engaged on behalf of the prosecution, had been prepared on the spot to say how much hydrocyanic acid was present in apple-pips, this strange suggestion would have been extinguished at once. It will, therefore, be prudent for toxicologists, when they have found any poison in the body of a deceased person, to consider whether such poison can be naturally present in any article of food or drink, and if so, in what quantity? Thus, suppose a case of poisoning by a salt of copper, and it appeared that the deceased had been in the habit of drinking cocoa or chocolate. The expert might save some trouble to himself and some time to the Court, by being prepared to say in what proportion copper naturally occurs in the cacao-bean and in its ordinary commercial preparations.

Another point raised in this case relates to the smell of prussic acid. Mr. Champneys, the surgeon who conducted the autopsy, was positive that he smelt prussic acid on opening the body. When afterwards the contents of the stomach were transferred to a jar, neither the three surgeons nor the analyst, Mr. Cooper, could detect the slightest odour, even on boiling the contents. The authors, therefore, are quite justified in their comments that "All tests involving odour are affected seriously by the remarkable differences between different people as to their sense of smell. We hear much of colour-blindness, but the analogous olfactory defect has almost escaped remark. Yet 'smell-blindness,' as I have formerly christened it, or anozism, if a Greek word be required, is exceedingly common, and chemists and medical men are frequently afflicted with it." Mr. Stewart gives instances from his own observation, of laboratory students who could not smell acetic acid, cyanogen, arseniuretted hydrogen, &c., and of an assistant who was fond of sulphuretted hydrogen!

Fully granting all that the author has said—and more—concerning the absence, the feebleness, the intermittence, and the anomalous character of the sense of smell in many persons, we must take exception to the term "smell blindness." We may venture to give a few suggestions for the benefit of persons who expect to be called upon to give an opinion on the presence, the absence, or the character of some particular odour. They should in the interval abstain from hot liquids, such as tea, coffee, soups, &c, from pungent and irritating condiments, from alcoholic liquors, and from tobacco in any shape. Just before smelling at the object, the mouth should be filled with the coldest water procurable.

In the shape of chemical notes on the Tawell case, there follows an exceedingly useful chapter on hydrocyanic acid, giving its synonyms, its physical and chemical characters, the strengths of its commercial forms; its occurrence in the vegetable world; the preliminary tests in supposed poisoning cases; its salts; its antidotes, medicinal uses, the fatal dose, the symptoms, the *post mortem* appearances, and the systematic procedure for its detection in the body.

Chapter IV.—"Trials for Poisoning by Strychnine"—introduces us to the more recent and still more sensational cases of Palmer and Dove. The former of these cases is pointed out by the authors as specially instructive from "the conflict of the medico-scientific evidence, the most eminent men among our physicians and analysts being called on either side, and the most contradictory testimony as to the possibility of detecting strychnine being given by them." Some persons—ourselves included—strongly question the wisdom of a system which makes the physician, the analyst, or other expert, seem the partisan of the side on behalf of which he is called, instead of, as we submit he should be, the impartial adviser of the Court. The authors, however, if we may argue from a quotation of Mr. Justice Stephen, seem scarcely at one with us on this important point.

Another important point is the necessity of absolute silence and secresy towards the public, on the part of the expert, until his report is presented in Court and he is examined thereon. In Palmer's case it would seem that the late Dr. A. S. Taylor, the eminent toxicologist, had approached very closely the limits of indiscretion. It appears that a gentleman on the staff of the *Illustrated Times* had contrived to obtain an introduction to Dr. Taylor. He concealed his connection with the press, and appeared as the representative of an insurance company, and asked for information concerning a number of poisoning cases that had occurred of late years. In consequence, at the trial no inconsiderable part of the cross-examination of Dr. Taylor was occupied by questions connected with the publication in the *Illustrated Times* of this version of the interview. A more serious consequence was that these statements in the *Illustrated Times*, copied into other papers, led Dove to resort to strychnine in order to poison his wife. Our readers will see the moral to be drawn.

The unsatisfactory feature of the trial is that strychnine was not actually found in the body of Cook, though his death took place with symptoms which the medical witnesses could refer to no other cause. It is remarkable that before his execution, whilst not denying that Cook was poisoned, he added, "but not with strychnine."

As in the case of prussic acid, a chapter is devoted to strychnine and brucine, their commercial sources, properties, separation, tests, doses, symptoms, *post mortem* appearances, &c.

The trial of Madeline Smith for poisoning L'Angelier with arsenic is, chemically speaking, of little moment, since the abundant presence of arsenic in the stomach of the deceased could not be contested. Somewhat similar was the case of Dr. Pritchard, condemned for poisoning his wife and his mother-in-law with antimony, aided, as regards the latter, with aconite. Nor need we refer at length to the case of Dr. Smethurst, in which the antagonism between Mr. Herapath and Dr. Taylor broke out in a somewhat irregular manner. The authors remark that "Taylor's tests both for arsenic and antimony were not reliable."

Lastly comes poisoning by aconitine, as illustrated in the recent case of Lamson. Aconitine, having no very striking chemical reactions, the evidence of the poison was mainly obtained by the experiments performed by Dr. T. Stevenson upon himself and upon a few mice. It is a curious fact, as showing the inconsistency of the public mind, that though thousands of mice are weekly destroyed by poisons more or less rapid, by traps, and by cats, without the least comment, yet the sacrifice of these few specimens for an important purpose called up no small displeasure. On this subject it is to be noted that counsel for the defence misquoted Dr. Tidy, and ascribed importance to a dictum of Lord Coleridge, whose opinions, on a physiological or chemical question, are about as valuable as would be our own on a point of law.

We must here close our survey of this work by pronouncing it henceforth indispensable to all chemists who practise in toxicology, of great value to the medical profession generally, and doubtless no less so to solicitors and counsel who may be concerned in poisoning cases.

The index is scarcely as complete as the nature of the work requires.

Reproduction of Albite in the Moist Way.—C. Friedel and E. Sarasin.—By the reaction of potassium and aluminium silicates at an elevated temperature in presence of water, the authors have obtained orthose in a crystalline powder capable of being microscopically determined. On proceeding in a similar manner with sodium and aluminium silicates in proportions representing the composition of albite, they obtained analcime, and finally, by adding to the above mixture a further quantity of sodium silicate and heating to about 500°, they produced albite in distinct crystals.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 5, July 30, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—Will be inserted in full.

Critical Temperature and Critical Pressure of Oxygen.—S. Wroblewski.—The temperature in question is about −113°, and the pressure 50 atmospheres.

Determination of the Internal Inert Resistance of any Electric System whatever, notwithstanding the Perturbing Actions of its Internal Electromotive Forces, unknown as to Number, Situation, and Magnitude.—G. Cabanellas.—A mathematical paper, not adapted for useful abstraction.

Visibility of the Ultra-Violet Rays.—J. L. Soret.—There is a region of the spectrum, extending to beyond the ray Q, composed of rays which are not notably absorbed by the media of the eye, and for which the sensibility of the retina is much inferior to that obtained with the fluorescent eye-piece.

Crystalline Calcium Phosphate produced during the Dephosphorisation of Cast-iron.—MM. A. Carnot and Richard.—These crystals were found in the cavities of slags obtained from the iron works of Jœuf. Their composition and their crystalline form are described.

Artificial Production of Rhodonite and Tephroite.—Alex. Gorgeu.—The author's method is founded on the reciprocal action of silica and manganese chloride at a red heat in presence of watery vapour. He considers that this may be the method in which these compounds have been produced in nature.

Menthyl Chloride.—G. Arth.—The author concludes that Oppenheim's menthyl chloride and his own menthene hydrochlorate are identical. The same fact has been already demonstrated by Kachler and Spitzer for borneol chloride and camphene hydrochlorate.

Acid Products from the Bacterian Fermentation of the Albumenoid.—Arm. Gautier and A. Etard.—The authors have obtained the following acids from the products of this fermentation:—The formic, acetic, butyric, valeric, and palmitic; the acrylic and crotonic; the glycolic, lactic, and valero-lactic; the oxalic, succinic, and carbonic; and lastly, of nitrogenous acids, $C_9H_{15}NO_4$, the amido-stearic, besides leucines and leuceines.

An Isomer of Laurene.—A. Renard.—The product in question is a light oil, not attacked by ordinary sulphuric acid, and boiling at from 193° to 195°.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., June, 1883.

The Colouring-Matters of Madder and their Metamorphoses.—A. Rosenstiehl.—The author gives a description of the colouring-matters obtained from madder, *i.e.*, alizarin, purpurin, hydrated purpurin, pseudo-purpurin, purpuro-xanthin, and munjistin. He remarks that pseudo-purpurin cannot exist in any extract or other commercial extract of madder which has undergone the action of hot water, such as garancin. It is only found in madder, fleur de garance, madder lake, and the commercial purpurin of Emile Kopp. The quantity of madder raised in the Vaucluse and Holland amounted to about 35 million kilos. yearly in the period 1859 to 1863. During 1870-71 it fell momentarily to 17 millions, and rose again immediately to its maximum 30 millions (?). From 1874 the increasing influence of artificial alizarin made itself felt, and in 1878 the yield of the Vaucluse was only 2 million kilos., and that of Holland 600,000. It then ceased in Vaucluse, where it is in effect abandoned, as also in Alsace, where, however, artificial data are wanting. At present madder is cultivated in Holland alone. In 1881 the production was 600,000 kilos., and 1,200,000 in 1882. The firms who manufactured the extract of madder have, substantially, ceased their operations. The industry created by Émile Kopp, however (pseudo-purpurin), still exists, producing an article which chemistry cannot obtain synthetically. Pseudo-purpurin has its special uses; in calico-printing it yields a very fine rose, which bears sunlight very well, though not soaping, and in the manufacture of pigments it is utilised as a valuable red lake.

Journal de Pharmacie et de Chemie. Tome viii., August, 1883.

Examination made by M. J. L. Soubeiran of a Thesis by M. Francois Gay on the "Micrographic and Spectroscopic Study of Tinctures and Alcoholates.—For making the microscopic examination of a tincture, the author brings it to such a consistence that the alkaloids present may crystallise. In spectroscopic investigation the author divides tinctures into those which do not give the spectrum of chlorophyll and those which do. The former group are sub-divided into those with continuous spectra and those showing absorption-bands.

Prolonged Anæsthesia obtained by Means of Nitrogen Protoxide at the Normal Pressure.—Paul Bert.—From the *Comptes Rendus*.

Action of Mixtures of Air and of the Vapour of Chloroform, and a New Process of Anæsthesia.—Paul Bert.—From the *Comptes Rendus*.

The Use of Ether and Chloroform in detecting Salicylic Acid in Wines.—R. Malenfant.—The author recommends chloroform as preferable to ether. He measures into a bottle 50 c.c. of the wine to be analysed and 20 c.c. of pure chloroform. The mixture is moderately shaken so as not to emulsify the chloroform too completely, thrown into a funnel with a ground glass cock, and let settle. After a few minutes the mixture separates into two layers, the chloroform at the bottom. About 10 c.c. are drawn off into a test-tube, and shaken up with a drop of ferric chloride and some c c. of water. If salicylic acid is present the characteristic violet colour appears in the watery stratum which floats above the chloroform.

The Action of Wines with Polarised Light.—S. Cotton.—M. Girard states that "piquettes" made from raisins turn the plane of polarisation to the left, while natural wines turn it to the right. The author finds that wine made from the grapes of an American vine (variety, Jacquez), gives a deviation to the left of −5°.

Alumed Wines.—M. Malenfant.—The author incinerates 100 c.c. of the wine in a platinum capsule, boils the ash repeatedly with soda-lye at 36° (B.?), passes through a Berzelius filter, adds to the liquid a little sal-ammoniac in solution, heats for a few minutes, collects the alumina on a filter, washes, ignites, burns the filter, and weighs.

Evonymine, its Properties and its Preparation.—Paul Thibault.—A pharmaceutical memoir.

An Organism which is developed in the Solutions of Calcium Diphosphate.—M. Royer.—The flocks suspended in the solution take the form of a yellowish mass, formed of elongated branching filaments. The plant in question is a Schizomycetic protophyte belonging to the genus Hygrocrocis.

Action of the Liquids of the Digestive Canal upon the Antimonial Compounds.—L. Garnier.—The hydrochloric acid of the gastric juice and the neutral salts (chlorides) of all the intestinal secretions have only a very

feeble action upon the derivatives of antimony. The organic acids and the alkalies dissolve them in considerable quantity.

Rapid Method for the Assay of Potassium Iodide.—M. Herbelin.—The author's process is based upon the fact that 332 parts of the iodide, in contact with 135·50 of mercuric iodide gives a colourless solution if the iodide is pure. As such absolute purity does not exist and is not required, a remedy of 5 per cent is allowed; thus reducing the figure 135·50 to 128·72. The author proceeds as follows:—Weigh out exactly 1 grm. of the sample, and dissolve it in 30 c.c. of water. These proportions correspond to 33·20 per litre. Measure with a drop-counter 20 drops of this solution into a glass. Add to this liquid with a drop-counter like the former, a solution containing 13·55 grms. mercuric chloride per litre, until a colouration appears. If the iodide is chemically pure 20 drops will be needed. If it contains 5 or 10 per cent of impurities, 19 or 18 drops will be respectively required.

Preparation of Hydrobromic Acid.—M. Gruning.—The author decomposes potassium or sodium bromide with phosphoric acid at a boiling heat. The specific gravity of the phosphoric acid employed is 1·304.

Cafeine and its Salts.—H. Biedermann.—An account of cafeine hydrochlorate, hydrobromate, hydriodate, nitrate, sulphate, auro-chloride, platino-chloride, formiate, acetate, butyrate, and valerianate.

Phosphorescence of Sulphur.—K. Heumann.—If sulphur is heated on a plate of metal or porcelain, its vapours, in the dark, give off a phosphorescent light. The flame is pale, scarcely bluish, very different from the fine blue flame given by the combustion of sulphur at higher temperatures. In place of sulphurous acid gas the phosphorescent sulphur emits vapours having an odour which recalls at once that of hydrogen bisulphide, of camphor, and ozone.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 6.

Experiments on the Dialysis of Arable Soil.—Prof. A. Petermann.—The author, on submitting various specimens of earth to dialysis, finds that arable soils give up to water, from which they are separated by parchment-paper, the following constituents of plant-food:—Lime, magnesia, iron, potassa, soda, sulphuric, phosphoric, and nitric acids, silica, and chlorine. Ammonia, though present in the soils, could not be detected in the water, even by Nessler's reagent, and is probably oxidised to nitric acid. Soils contain organic matter which readily diffuses through parchment-paper.

Influence of Manuring upon the Composition of Potatoes.—Profs. Märcker, Graeger, and Vibrano-Calvörde.—The use of soda-saltpetre increased the gross weight of the crop, but the total dry matter was decreased; the starch was diminished by 6 per cent, but the albumenoids were increased.

Influence of Early or Late Manuring with Kainite upon the Proportion of Starch in Potatoes.—Dr. M. Fleischer.—The use of potash favours the gross yield, upon which the time of its application seems to have no influence. As regards the proportion of starch, a kainite dressing in autumn is most favourable.

Manurial Value of Peat used as a Layer for Cattle.—Dr. M. Fleischer.—The fibrous peat of Silesia and Wurtemberg has a higher manurial value than the moss-turf of North Germany.

Manurial Experiments on Rye and Wheat in the Province of Saxony.—Prof. M. Maercker.—The author concludes that the use of phosphates alone does not increase the crop, even in superior sandy soils. Phosphate in conjunction with nitrogen is, however, to be strongly recommended. Steamed bones are the best form of phosphate for sandy soils.

Use of Artificial Fertilising Agents in the Cultivation of Potatoes.—S. Guradze.—The author gives a favourable report of the effects of the recently-patented "potash-magnesia," containing 50 per cent potassium sulphate and 34 per cent magnesium sulphate.

Manuring Sugar-Beets.—Prof. Holdefleiss.—The author recommends the moderate use of farmyard manure, aided by soda-saltpetre.

Manurial Experiments in the Vineyards of the Ahr Valley.—Dr. A. Stützer.—An artificial manure containing 7 per cent soluble phosphoric acid, 6 per cent potash, and 2½ to 3 of nitrogen, gave 20 per cent more grapes than farmyard manure. The above-mentioned mixture gave also the highest proportion of sugar and the lowest of acid.

Influence of the Electric Light upon the Development of Plants.—P. P. Deherain.—The author shows that the electric light contains rays harmful to vegetation, which, however, are chiefly held back by transparent glass. It contains enough of the rays useful to vegetation to maintain the life of plants under its sole influence for two months and a half. The quantity of favourable rays is too small to ripen crops.

Moniteur Scientifique, Quesneville.
August, 1883.

This number contains merely a translation of Professor Hofmann's biography of the late F. Wœhler; a verbatim report of the discussion in the Chamber of Deputies on the proposed increase of the pension awarded to M. Pasteur; and the usual report of the proceedings of the Academy of Sciences.

Justus Liebig's Annalen der Chemie,
Band 219, Part 1.

Vulpianic Acid.—Adolf Spiegel.—The author has discovered a new compound, pulvinic acid, from which vulpinic acid may be considered as derived. To this new acid he assigns the formula $C_{18}H_{12}O_5$, vulpinic acid being $C_{19}H_{14}O_5$. In the present memoir he discusses in succession the direct derivatives of pulvinic acid, its reduction products, its oxidation, oxytolylic acid, and the constitution of pulvinic and vulpinic acids.

Communications from the Chemical Laboratory of the University of Jena.—These consists of a paper by A. Geuther on the yellow and red oxides of lead; a memoir by Dr. W. Wedel on certain derivatives of acet acetic ester (ethyl-diacetic acid); and a paper by A. Geuther on the constitution of acet-acetic ether, and on that of benzol.

Cosmos les Mondes.
Tome v., No. 12, July 21, 1883.

Combination-Heats of the Soluble Compounds of Lithium.—Dr. D. Tommasi.—The author gives the comparative combination-heats of lithium sulphide as calculated and determined experimentally, and furnishes also a table of the calculated heats of the principal lithium compounds.

No. 13, July 28, 1883.

The Use of Cadmium Tungsto-borate for the Mechanical Analysis of Rocks.—D. Klein.—The sp. gr. of this solution is 3·281, and it consequently permits of the mechanical separation of a number of metals.

ERRATA.—P. 7, col. 1, *for* "scarifier" *read* "scorifier"; line 9 from bottom, *for* "test" *read* "rest." P. 8, col. 1, under "Grms. $Mg_3As_2O_7$," *for* "0·0671" and "0·0671" *read* "0·0762" and "0·0761"; col. 2, line 27 from top, *for* "0·2" *read* "0·25"; line 41 from top, *for* "two" *read* "four." P. 9, col. 1, under "Grms. Ore," *for* "0·2" *read* "0·1" in each case.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883, when the Prizes for the past Session will be distributed, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physicianeies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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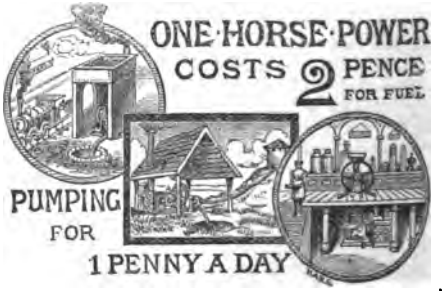

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1239.

VOLUMETRIC METHOD FOR ESTIMATING ARSENIC.

By ALBERT H. LOW.

In the Chemical News of July 6, 1883, appeared an article by Leroy W. McCay on "A New Volumetric Method for Estimating Arsenic," in which a paper on the same subject lately read before the Colorado Scientific Society by Mr. Richard Pearce was referred to and criticised. I will endeavour to show that this criticism was unsound.

Mr. Pearce's method depends upon the insolubility of arseniate of silver under certain conditions. These conditions are attained as follows:*—A fusion of the arsenic compound is made with carbonate of sodium and nitrate of potassium. The soluble portion is afterward extracted with water and filtered. The filtrate is acidified with nitric acid and boiled. It is then cooled and almost exactly neutralised with ammonia, leaving, however, a slight alkaline reaction. These are the conditions. A neutral solution of nitrate of silver is now added in slight excess which precipitates the arsenic as arseniate of silver.

The following is Mr. McCay's criticism on the above:—"Silver oxide is precipitated by ammonium hydroxide from a neutral solution of a silver salt, and it is only upon the addition of an excess of the alkali that the precipitate can again be brought into solution. The question now arises, is there not danger of precipitating some silver along with the arsenic? If so will this not serve to vitiate the method? To settle the matter, I took about 2½ c.c. of a strong solution of silver nitrate, diluted with water to about 50 c.c., and after heating to boiling, added a drop of dilute ammonium hydroxide solution—no precipitate; two drops, no precipitate; three drops, no precipitate; twelve drops, none.

The solution was next tested with litmus paper, but showed absolutely no alkaline reaction. When the ammonia was allowed to run in until the resulting reaction was faintly alkaline, a distinct cloud, due to the formation of silver oxide, made its appearance. This cloud, by permitting the solution to stand for some time, became larger and larger, but soon reached a maximum. In opposition, therefore, to Pearce and Low, I declare that the solution immediately prior to precipitation dare not be alkaline!" Now it will be observed that the result on which the criticism is based is obtained under conditions quite different from those of Mr. Pearce's method. The most important difference is in the comparative amount of nitrate of ammonium present. By Mr. Pearce's method there is always a considerable excess of nitrate of ammonium, in which oxide of silver is sufficiently soluble, and but very little oxide of silver to be dissolved by it, as only so much is liberated as corresponds to the amount of free ammonia present, while in Mr. McCay's experiment the small amount of nitrate of ammonium formed is surcharged with oxide of silver, which finally begins to precipitate.

If at this point Mr. McCay had added a few crystals of nitrate of ammonium he would have seen the precipitated oxide of silver immediately disappear. Or, if he had previously dissolved a little nitrate of ammonium in the silver solution he would have obtained no precipitate at all with ammonia. This point was carefully tested before Mr. Pearce's method was made public. The direction to have the solution slightly alkaline instead of perfectly neutral was given advisedly, as it was found that a perfectly neutral solution containing much arsenic (as alkaline arseniate obtained by fusion), became decidedly acid on the addition of a neutral solution of nitrate of silver,* a fact that has apparently escaped Mr. McCay's observation. By making the solution slightly alkaline to start with the tendency to become acid is usually sufficiently neutralised when only a small amount of arsenic is present. The filtrate is always tested, and if found too acid it is carefully neutralised and re-filtered. In practice this is rarely necessary on account of the small quantity of substance taken for analysis. I seldom find any arsenic in the filtrate and when I do it occasions but very little delay to filter it through the original filter (from which the bulk of the arseniate of silver has previously been dissolved) and then wash it with acid into the main portion. The method was originally intended simply as a rapid and sufficiently accurate process for estimating arsenic in copper ores and furnace products, but an almost daily use for over six months has convinced me that it possesses great reliability and accuracy. I have not had an instance where the disagreement between duplicates exceeded one-tenth of a per cent. This could not be the case were the above criticism well founded. I see no advantage as regards either time or accuracy in Mr. McCay's modification of the process. In fact I consider the plan of dissolving the precipitated arseniate of silver in dilute nitric acid and titrating for the silver better than that of Mr. McCay, in which the excess of silver, remaining after precipitation of the arseniate, is determined, on account of the great liability of the reagents to contain chlorine. While this impurity would not affect Mr. Pearce's process it would cause the results by Mr. McCay's method to come low.

Regarding the proper treatment of sulphide of arsenic, which Mr. McCay is "endeavouring to discover," I will say that if after oxidising with fuming nitric acid he will evaporate to dryness and then make the usual fusion with the residue, he will have no further trouble. When the amount of sulphide has been small I have obtained perfectly satisfactory results by fusing directly without previous oxidation.

I trust the above explanations are sufficiently clear to remove all doubt from Mr. McCay's mind relative to the reliability of Mr. Pearce's process; if not, I shall be happy to give any further details he may require.

Argo, Colo., July 30, 1883.

I subjoin the following published description of Mr. Pearce's process, observing, however, that a platinum crucible is much better than one of porcelain. Afrer the fusion it can be cooled at once in water, thus saving much time, and it appears to be but very slightly acted upon. I have used one in a large number of determinations with ores and furnace products containing high percentages of arsenic, copper, lead, and sulphur, and it remains apparently uninjured.

The Estimation of Arsenic.†

By O. J. Frost, Argo, Colo.

Mr. Richard Pearce, of the Boston and Colorado Smelting Company, Argo, Colo., has long felt the need of a rapid and reliable method for the estimation of arsenic in ores and metallurgical products, and more particularly in copper ores and copper smelting products. After a great many experiments in different directions, the following scheme, depending upon the insolubility, under certain conditions, of silver arseniate in neutral solutions, has been found to work well. It was described by him in a paper read before the Colorado Scientific Society.

The finely-powdered substance for analysis is mixed in a large porcelain crucible with from six to ten times its weight of a mixture of equal parts of carbonate of sodium and nitrate of potassium. The mass is then

* At the time this method was worked out Mr. Pearce had not heard of Reich and Richter's process.

* Presumably in accordance with one or both of the following reactions or those of the corresponding potassium salts:—

$3AgNO_3 + NaH_2AsO_4 = Ag_3AsO_4 + NaNO_3 + 2HNO_3$.

$3AgNO_3 + Na_2HAsO_4 = Ag_3AsO_4 + 2NaNO_3 + HNO_3$.

† From the *Engineering and Mining Journal*.

heated with a gradually increasing temperature to fusion, and kept for a few minutes in that state. It is then allowed to cool, and the soluble portion is extracted by warming with water in the crucible, and filtering from the insoluble residue when disintegration is complete. The arsenic is in the filtrate as alkaline arseniate. The solution is acidified with nitric acid and boiled to expel carbonic acid and nitrous fumes. It is then cooled to the ordinary temperature, and almost exactly neutralised as follows:—Place a small piece of litmus-paper in the liquid: it should show an acid reaction. Now gradually add strong ammonia till the litmus turns blue, avoiding a great excess. Again make slightly acid with a drop or two of strong nitric acid; and then, by means of very dilute ammonia and nitric acid, added drop by drop, bring the solution to such a condition that the litmus-paper, after having previously been reddened, will, in the course of a half a minute, begin to show signs of alkalinity. The litmus-paper may now be removed and washed, and the solution, if tolerably clear, is ready for the addition of nitrate of silver. If the neutralisation has caused much of a precipitate (alumina, &c.), it is best to filter it off at once, to render the subsequent filtration and washing of the arseniate of silver easier.

A solution of nitrate of silver (of neutral reaction) is now added in slight excess; and after stirring a moment, to partially coagulate the precipitated arseniate, which is of a brick-red colour, the liquid is filtered, and the precipitate is washed with cold water. The filtrate is then tested with nitrate of silver and dilute nitric acid ammonia, to see that the precipitation is complete.

The object is now to determine the amount of silver in the precipitated arseniate of silver, and from this to calculate the arsenic. Two methods may be employed, the conveniences of a laboratory determining which is preferable: (1) The arseniate of silver may be subjected to scorification (or fusion) and subsequent cupellation. This necessitates the removal, earlier in the process, of any soluble chloride present. (2) The arseniate of silver may be dissolved on the filter with dilute nitric acid (which leaves undissolved any chloride of silver), and the filtrate titrated, after the addition of ferric nitrate or sulphate, with sulphocyanate of ammonium. About five cubic centimetres of a saturated solution of ferric-ammonio-sulphate are added, and the standardised sulphocyanate solution (about 5 grms. to the litre) run in until a faint red tinge is obtained, which remains after considerable shaking. The shaking breaks up the clots of sulphocyanate of silver and frees any solution held mechanically.

From the formula $3Ag_2O.As_2O_5$, we deduce 648 parts Ag = 150 parts As, or Ag : As = 108 : 25 :

	As Per cent.
1-10 of a grm. of a sample enargite tested by this method gave	19·030
A second trial showed	19·090
To try the effect of antimony, 1-10 of a grm. of the enargite was mixed with an equal weight of stibnite and tested: the result was	19·130
The arsenic in the enargite determined by the arseniate of magnesia and ammonia method showed	19·440
A sample of copper glance was tested, and found free from arsenic. This was then added in sufficient quantity to the enargite to produce a mixture calculated to contain	0·370
0·55 grm. was taken for analysis and showed	0·380
A test on 1-20 of a grm. of pure proustite gave	15·080
Theoretical	15·150
A sample of copper matte gave first trial	0·470
Second trial	0·460
Another sample of copper matte gave, on first trial	0·280
Second trial	0·284
A sample "pimple" metal gave	0·458
Repeated	0·459

Additional experiments have been equally satisfactory.

This method for the estimation of arsenic is not only accurate, it is short also. By process (2) an estimation can easily be made in half an hour; and an estimation has been made by Mr. A. H. Low in the Laboratory of the Boston and Colorado Smelting Company at Argo, where the details of the process were worked out in twenty-two minutes.

Owing to the large amount of arseniate of silver formed from a small quantity of arsenic (nearly six times by weight), it is not at all necessary or even desirable to work with large amounts of substance. Half a grm. is usually sufficient for the determination of the smallest quantity of arsenic; and where the percentage is high, as little as one-tenth or one-twentieth of a grm. may be taken with advantage. The method has been used with very satisfactory results on the sulphide of arsenic obtained in the ordinary course of analysis.

Substances such as molybdic and phosphoric acids, which may behave similarly to arsenic under this treatment, interfere, of course, with the method. Antimony, by forming antimoniate of sodium, remains practically insoluble and without effect.

It is quite probable that the method could be adapted for the rapid estimation of phosphorus in commercial products and in iron and steel; but beyond a few preliminary experiments, nothing has been attempted in this direction.

SEPARATION OF GALLIUM FROM VANADIUM.

By M. LECOQ DE BOISBAUDRAN.

The author has only found a single process which if used alone enables us to effect this analysis with accuracy. We may succeed, however, very well by combining several methods, as will be explained below.

1. The hydrochloric solution, slightly acid, is mixed with arsenious acid and an excess of acid ammonium acetate, and is then treated with a current of sulphuretted hydrogen. Under these circumstances the vanadium is not precipitated. The galliferous arsenic sulphide, previously washed in water containing a little acid ammonium acetate and sulphuretted hydrogen, is treated with aqua regia. The arsenic acid is reduced by sulphurous acid, and sulphuretted hydrogen is passed into the strongly acid hydrochloric solution. The arsenic sulphide no longer contains any gallium, and the latter may be obtained by evaporating the filtrate. This process is especially advantageous for extracting traces of gallium mixed with large quantities of vanadium compounds.

2. The hydrochloric solution of the vanadic or vanadous compound containing gallium is neutralised almost entirely with ammonia, and an excess of ammonium sulphide is added drop by drop, stirring all the time. A decided excess of hydrochloric acid is then added drop by drop, still stirring. There is thus precipitated vanadyl sulphide, which is received upon a filter and washed with very dilute hydrochloric acid containing hydrogen sulphide. The clear liquid is boiled with aqua regia in order to destroy the ammoniacal salts and to diminish the bulk: the last traces of nitric acid are expelled, and the liquid is treated as above. After six or seven similar operations only a very small quantity of vanadium remains with the gallium chloride. As for the vanadyl sulphides obtained, they retain traces of gallium, which are separated by dissolving in aqua regia and re-commencing the series of treatments with ammonium sulphide and dilute hydrochloric acid. This process is long, and little applicable except in certain particular cases.

3. The hydrochloric solution of the galliferous vanadic or vanadous compound is supersaturated with ammonia, and boiled until a piece of litmus-paper placed in the liquid begins to turn red. The boiling must not be carried further, in order to prevent the formation of acid ammonium vanadiate (of a yellow colour), which seems to

dissolve a small quantity of gallium oxide. It sometimes happens that the boiled solution remains of a deep green. In this case a few drops of ammonia are added, and the boiling is repeated when the liquid becomes colourles. In spite of every precaution the filtrates, rich in vanadium, retain traces of gallium, which though small cannot be neglected. The gallium oxide also carries with it vanadium; it is therefore re-dissolved in hydrochloric acid, and the boiling with ammonia is repeated a second time, but without thus effecting the entire removal of the vanadium. This process serves merely for obtaining expeditiously on the one hand a solution containing the great bulk of the vanadium with traces of gallium, and on the other, a precipitate containing almost all the gallium with a small quantity of vanadium.

4. The mixture of salts of gallium and of vanadic or vanadious compounds is mixed with sulphuric acid and ammonium sulphate in proportions suitable for forming ammoniacal-gallic alum. The operation is conducted as described in *Comptes Rrndus*, 1883, p. 143. After two or three re-crystallisations the alum is free from vanadium, but a small quantity of gallium remains in the solution of vanadium.

In an accurate analysis the author proceeds as follows in the three cases given,—the only ones which can occur:—

A. Much vanadium and very little gallium. The process No. 1 must be used.

B. Very little vanadium and much gallium. The larger portion of the gallium is removed by process No. 4, and the residual liquid comes under case C.

C. Both gallium and vanadium are present in considerable quantities. We commence with two successive boilings with ammonia (process No. 3), which gives vanadiferous gallium oxide and a solution rich in vanadium and very poor in gallium. This solution is treated as under case A. The vanadiferous gallium is transformed into alum free from vanadium. The mother-liquors, when boiled with ammonia, furnish a vanadic liquid very poor in gallium (to be added to A), and a small quantity of vanadiferous gallium oxide, from which a little pure gallium alum is extracted. When the mass is become too small to permit of the preparation of alum, it is added to the liquids A, which are freed from gallium by the arsenic sulphide process (No. 1).—*Comptes Rendus*.

ON THE EXAMINATION OF FATS.

By K. ZULKOWSKY.

SOME time ago Max Gröger submitted Hausemann's method of titration for mixtures of neutral fats and fatty acids to a thorough examination in the author's laboratory. He has succeeded in improving and simplifying the method to such an extent that it is now easier to determine such a fatty mixture than a mixture of caustic soda and sodium carbonate. The method is based upon the fact that a fatty acid in an alcoholic solution is immediately saponified by an alcoholic solution of potassa, whilst with neutral fats this change ensues only on prolonged boiling. If we therefore add phenol-phthaleine to the alcoholic solution of fatty acids and neutral fats, and titrate with caustic potassa, the red colour disappears instantly as long as free fatty acids are present. When these are saturated the liquid turns red. If an excess of solution of caustic potassa is added and the liquid is boiled for half an hour, the neutral fat is saponified, and on titrating back we find the volume of the potassa solution which has been required for saponifying the neutral fat. From the consumption of this test-liquid in the saponification of the fatty acids and of the neutral fats, their quantity can be calculated, even if the weight of the mixture is not known. This is the principle of this simple and elegant method, which, according to test-experiments, yields very accurate results.

On further consideration the author regards Hausemann's idea as a mine from which may be obtained much that will be useful in the technology of fatty matters. Several cases follow in which it gives exceedingly valuable conclusions in testing fats.

1. It is possible to ascertain the equivalent of a fat, *i.e.*, the quantity of it which is saponified by an equivalent of caustic potassa, or by a litre of normal potassa. This figure gives in certain cases an indication concerning the nature of the fats. In the examination of butters the equivalent will beyond doubt show whether we have to do with a natural or a factitious butter. Whether it will be possible to detect a mixture of both with certainty must be decided by future experiments.

2. We are enabled to determine directly and in the simplest possible manner the proportion of glycerin in fats, *i.e.*, the theoretical yield of glycerin. In titrating a neutral fat or a mixture of several fats, the following reaction takes place:—

$$\underbrace{C_3H_5(O.C_nH_{2n-1}O)_3}_{\text{Neutral Fat.}} + \underbrace{3KOH}_{\text{Caustic Potassa.}} = \underbrace{C_3H_8O_3}_{\text{Glycerin.}} + 3\underbrace{(C_nH_{2n-1}O.OK)}_{\text{Potassium Salt of a Fatty Acid.}}.$$

According to this equation, for every litre of normal potassa ⅓rd of an equivalent, *i.e.*, 30·667 grms., of glycerin will be liberated, or 1 c.c. normal alkali represents 0·030667 grm. glycerin. The determination of the proportion of glycerin in fats is at present of great technical interest, as in consequence of the growing demand and the high market price the yield of glycerin cannot be left out of consideration.

3. When the proportion of glycerin has thus been established by titration if the fat is pure and free from water, the theoretical yield of fatty acids appears at once. The tri-glycerides can be regarded as decomposed as follows:—

$$\underbrace{C_3H_5(O.C_nH_{2n-1})_3}_{\text{Neutral Fat.}} = \underbrace{C_3H_2}_{\text{Glycerin Residue.}} + \underbrace{3C_nH_{2n}O_2}_{\text{Hydrated Fatty Acid.}}$$

If we compare this equation with the former one, 1 litre normal alkali corresponds to ⅓ equivalent, *i.e.*, 12·667 of the glycerin residue, C_3H_2. If v c.c. normal alkali have been consumed, the weight of the glycerin residue $(0{\cdot}012667\,v) = G$, and if F grms. of the neutral fat have been weighed out $(F - G)$ is the quantity of the fatty acids.

4. If the proportion of fatty acid $(F - G)$ has been thus determined their equivalent follows. If we have used v c.c. normal alkali the equivalent results from the following proportion:—

$$(F - G) : A = v : 1000.$$

$$A = \frac{1000\,(F - G)}{v}.$$

—*Berichte Deutsch. Chem. Gesell.*

NOTES ON THE METALLURGY OF NICKEL IN THE UNITED STATES.*

By WILLIAM P. BLAKE, F.G.S., New Haven, Conn.

THE metallic element Nickel, discovered by Cronstedt, the mineralogist, in the year 1751, as a peculiar metal in kupfer-nickel, remained for a long time comparatively unknown in its true characters. It was at first obtained as a secondary or by-product, in the manufacture of extraction of cobalt, being found concentrated in the cobalt speiss left in the pots when smalt or cobalt-blue glass was manufactured. Cobalt at that time was the product chiefly sought, and nickel in its applications was unknown.

* Read at the Boston Meeting of the American Institute of Mining Engineers, Feb., 1883.

Since the discovery of the artificial ultramarine blue, the demand for cobalt has been lessened, while the increasing uses of nickel have made it of first importance, and the conditions are thus reversed.*

But the nickel so reduced from the residues was contaminated with copper, iron, or arsenic, and in this condition it entered into the composition of the familiar alloy commonly known as German silver, but properly known as nickel silver.

The so-called nickel or nickel bronze was a complex, irregularly constituted alloy, in which less than one per cent of arsenic was sufficient to greatly modify its physical properties. And it was difficult to free the metal from this element. It may be said that until within a few years, the element nickel, in its true characters and in a comparatively pure condition, was commercially unknown.

To the scientific chemists, however, its true physical properties early became known, though not without some contradictory and varying results, at first, resulting no doubt from minute differences of composition of their samples according to the nature of the processes employed for the extraction of the metal. Richter found that nickel oxide strongly ignited in an earthen crucible with carbon, gave the metal in a perfectly malleable, ductile condition. It could be hammered cold or hot into plates 1-100th of an inch in thickness, and could be drawn into wire 1-56th of an inch in diameter.† Its malleability was found to be diminished by carbon or manganese. On the other hand, Tupputi found that nickel reduced in the presence of carbon in a covered charcoal crucible and under glass, formed more or less nickel-graphite, absorbed a portion of carbon, and was less ductile than zinc. It was brittle when cold, and was as fusible as cast-iron (Erdmann), while the metal obtained by Richter was difficult of fusion. He also noted that nickel could be welded, but Tourte found that it welded but imperfectly.

Deville cited cobalt and nickel as metals with useful physical properties but little known, such as malleability, ductility, and a tenacity surpassing that of iron. He showed that these metals could be worked at a forge with the same facility as iron; that they were susceptible of being employed in the same manner and were less oxidisable.‡

Inasmuch as nickel first became known commercially in the industrial arts in the form of an alloy, there were no special attempts to produce the metal in a state of extreme purity. The nickel silver of commerce answered all the existing demands, and was of course much easier to make, and cheaper than the pure nickel. It found a large and rapidly extending consumption as a substitute for silver spoons and forks and for silverware generally, especially when the new art of electro-plating was developed by Spencer, Smee, and others. The nickel silver was specially well adapted to receive and hold the deposit of silver, and it is to this day the most desirable alloy for plating.

The use of nickel alloy for small or subsidiary coins next made an increased demand for nickel. Tentative efforts were made by Dr. Feuchtwanger, in New York, in the year 1837, and he actually issued many small one-cent and three-cent pieces, made of a nickel alloy, the exact composition of which he was careful not to state, but called it "Feuchtwanger's composition." Switzerland commenced using nickel alloy coins in 1850; the United States in 1857, though sample coins, one-cent pieces, had been made by Professor James C. Booth, at Philadelphia, in 1853, the prepared alloy containing from 5 of nickel and 95 of copper, to as high as 30 of nickel, and 70 of copper. The alloy adopted by law consisted of 12 of nickel and 88 of copper. The five-cent pieces now in circulation are made of an alloy of 25 parts of nickel and 75 parts of copper. In 1860, Belgium adopted an alloy of the same proportions, for small coins. Other countries have followed, until the use of nickel alloy for small coins may be said to be almost universal in the chief commercial countries. Up to June 30th, 1876, the United States had alone issued of the five-cent nickel to the extent of 6,716,129 dols. in value. Another sudden demand for a larger supply of nickel sprung up when the art of depositing nickel by electricity was perfected. The many and increasing applications of this art need not be here enumerated. It is sufficient to state that at the present time, they constitute a large part of the present consumption of the metal in this country, where the art may be said to have originated in a successful, practical form.

Nickel ore is more generally distributed throughout the mineral-bearing portions of the United States than is generally supposed. It is commonly associated with chrome ores from Canada to Maryland, on the Atlantic side, and equally with the chrome ores of the Pacific slope, notably in Oregon. It is also a common associate of magnetic pyrites in the Archæan rocks, being found in Litchfield county, in Connecticut; in the Highlands of the Hudson, in New York, and in New Jersey; and especially at Lancaster Gap, in Pennsylvania, where the chief supply of nickel has been obtained for the United States. This ore yields from 1½ to 2 per cent of nickel, but is enriched by smelting at the mine into a matte containing 10 per cent or more of the metal. This locality was worked some thirty years ago by Prof. James C. Booth and others, of Philadelphia, and some nickel alloy was made. Some ten years later Mr. Joseph Wharton purchased the works and established the industry at Camden, N.J., opposite Philadelphia, where it has since been carried forward.

A large portion of the metal produced at these works by Mr. Wharton has been used at the United States mint for the subsidiary small coins, and a considerable amount has been exported. Since the development of nickelling by galvanism, a large part of the product has been put into the form of nickel salts and anodes.

But Mr. Wharton not being content with the production of impure nickel, early commenced experimenting to determine whether nickel could not be produced in a pure and malleable condition, susceptible of being worked in nearly the same manner as iron, and of being applied in the manufacture of various objects requiring strength of material and a material that cannot be easily oxidised. One of his earliest experiments was to take the somewhat spongy mass got by reduction of the oxide of nickel, and after heating it to full redness, work it under a steam hammer into a bar.

In 1873, Mr. Wharton sent to the Vienna Exhibition a sample of nickel in the form of axles and axle-bearings, and at the Exhibition in Philadelphia in 1876, he exhibited a remarkable series of objects made of *wrought nickel*, such as bars, rods, a cube, a horse-shoe magnet, and magnetic needles of forged nickel. These did not excite the interest to which they were entitled as a remarkable advance in the working of this little-known metal. The exhibit did not cause much comment, and it was not specially described or reported upon, so far as I am aware, except by the judges who reported the exhibit to the Commission as worthy of an award in the following terms: "A fine collection of nickel ores from Lancaster County, Pa., with nickel-matte, metallic nickel in grains and cubes, and manufactured nickel, both cast and wrought; nickel magnets and magnetic needles, cast cobalt, electro-plating with nickel and cobalt, and salts and oxides of both these metals; the whole showing a remarkable degree of progress in their metallurgical treatment."*

Some of the same objects formed of wrought nickel, were sent over to Paris two years later, and were exhibited in the American Section in 1878. There, as in Philadelphia, they did not at first excite any surprise, or receive any special attention. Very few persons realised what the objects really were, and that they were very different

* See Daubrée, *Substances Minerales*, p. 158.
† Cited in Gmelin, v., 361.
‡ *Comptes Rendus.*

* Reports and Awards, Group I., 640, p. 470.

from *alloys* of nickel. In fact, very few chemists had ever seen *nickel*. Pure nickel was a rarity, a curiosity, just as samples of indium or thallium are to-day.

You can then, perhaps, imagine the incredulity of the expert chemists and metallurgists of Europe, when whole ingots and forged bars of metal and numerous finished articles of pure wrought nickel, without alloy, were offered for their inspection. These articles not differing greatly in their appearance from the higher grades of nickel alloys, or from electro-nickelled objects, they passed them without surprise. No previous exhibition had been so rich in exhibits of the use of nickel and in the products from them. The influx of the pure carbonated and oxidised ores from New Caledonia, had greatly stimulated the nickel industry in Europe, and had improved the quality of the alloys of nickel. New companies had been formed to manufacture nickel silver and to produce nickel from these superior ores, at a lower cost than had before been possible. Christofle of Paris had just erected extensive works at St. Denis, and had made a most brilliant display of his products in one of the main avenues ot the Exposition. The Vivians of Swansea and other exhibitors had large cases filled with beautiful objects of hollow and solid ware made of nickel silver. Amid these various exhibits of striking *tours de force*, the modest little show-case from the United States with examples of manufactures of *pure wrought nickel*, not alloy, could hardly be expected to excite attention and win the golden award, which was most cheerfully accorded as soon as the fact was demonstrated by analysis that the objects were really of the pure metal. Some of the objects now shown were of that exhibition, and have retained their brilliant polish and lustre unimpaired. These notable advances in the metallurgy of nickel, made with the lean and sulphuretted ores of Lancaster Gap, prepared the way for greater advances.

Dr. Fleitman, of Iserlohn, Westphalia, Prussia, has improved and cheapened the operation of refining the nickel and toughening it, and has reduced the liability to the presence of blow-holes in castings by adding to the molten charge, in the pot, when ready to pour, a very small quantity of magnesium. This is immediately decomposed, magnesia is formed, and graphite is separated. It would seem that the magnesium decomposes the occluded carbonic oxide, or reduces it to a minimum. The magnesium must be added with great care, and in small portions, as it unites explosively with the charge. It is stirred in. About one ounce of magnesium is sufficient for 60 pounds of nickel. Three-quarters of an ounce to 54 pounds of metal has been used with success by Mr. Wharton. The nickel from the ore at Lancaster Gap, seems not to require as much as the foreign metal. It is to be noted that complete malleability of nickel was obtained at Wharton's Works in Camden, before Fleitman's invention or process, but this last is more rapid and better than the old method. The metal so treated becomes remarkably tough and malleable, and may be rolled into sheets and drawn into wire. Cast plates can be successfully rolled. The cast plates, such as are made for anodes, after re-heating are rolled down to the desired thickness. It is found that it is a great improvement to the nickel anode plates to roll them down. They dissolve with greater uniformity in the bath. Nickel so treated with magnesium has been rolled into sheets as thin as paper. Expensive works for rolling the metal have been erected by Mr. Wharton at Camden. There is already a train of 40-inch rolls, 18 inches in diameter, with annealing ovens and gas furnaces and their adjuncts, and a 90 horse-power engine. At present this mill as well as the works for producing the metal, and the mine also, are "shut down."

The largest sheet yet rolled at Camden was 72 inches long and 24 wide, of pure nickel.

Dr. Fleitman has also succeeded in welding sheet nickel upon iron and upon steel plates, so as to coat them equally on each face with a layer of nickel. The quantity preferred by weight is 8-10ths iron and 3-10ths nickel, 1-10th of nickel being placed on each surface. To secure union the iron or steel must be perfectly flat and clean. A pile is made with outer facings of sheet iron to protect the nickel from scaling. When the whole is heated to the proper degree, it is passed through the rolls. The two metals become so firmly united that they may afterwards be rolled down, two or three together, or separately, to the thinness desired.

The samples exhibited were cut from sheets made at Mr. Wharton's works at Camden. One sample No. 20 gauge, 10 per cent nickel; one sample No. 22 gauge, 10 per cent nickel; one sample showing edge of sheet.

These are all examples of nickel upon iron. I also show a thin sheet of pure nickel annealed. The physical properties of the two metals, iron and nickel, are so nearly the same that they work well together. The nickel surface cannot be removed or regained in the scrap and waste except by dissolving out the iron core by dilute sulphuric acid. In the earlier experiments, the ingots or cast plates were beaten under the hammer; this produced a great deal of scale and waste, as with iron, but this is now avoided, partly by the device of a thin covering of sheet iron which is afterwards dissolved off. Dr. Fleitman claims to have produced steel wire similarly coated, and proposes to make nickelled boiler plates.

The applications in the arts of such nickelled iron sheets as I have described, will readily suggest themselves. Up to this time the most direct uses seem to be in making hollow ware, particularly culinary vessels. The manufacture has already begun at Schwerte, by Dr. Fleitman, and a great variety of vessels, such as saucepans and kettles have been turned out, some of them of pure sheet nickel. They are all very beautiful in appearance, resembling highly finished platinum vessels more than ordinary ware. When planished and buffed off, the surface becomes like a mirror, and will answer the purpose of one. The small vessel exhibited is made of nickelled iron, and will show the facility with which the compound sheet metal may be stamped, spun up, and polished. Much larger specimens of ware might be shown.

This ware is believed to be far superior to tinned iron or tinned copper for cooking in. The nickel is not only less liable to corrosion, but is harder, will wear longer, and cannot be melted off by overheating. The ware is lighter and stronger than tin or copper ware; is susceptible of a high polish and is not easily tarnished. It appears to be well adapted to the manufacture of dishes, salvers, and covers for the table. The coating of nickel applied by welding is stronger and tougher than that deposited by electrolysis, and appears to be less liable to scale off. The electrically deposited metal is in some cases very brittle, and no doubt contains sufficient hydrogen to essentially modify the physical characters of the coating.

My purpose in this article is chiefly to record some of the most notable advances in the metallurgy of nickel made in the United States, and particularly to direct attention to the production by Mr. Joseph Wharton at his works in Camden, before the year 1876, of *pure nickel* in a malleable state and in considerable quantities, and the manufacture of useful articles from it by forging and working it in the same manner as iron is forged and worked; thus exhibiting for the first time, in the "large way," the true physical characters of this metal, and its adaptation to many purposes in the arts, as had already been partly indicated, in the "small way," by scientific chemists in their laboratories.

I also desire to direct attention to the improved magnesium process of Dr. Fleitman; to the manufacture of nickelled iron and steel in rolled sheets, and to the industries which the possession of pure nickel in commercial quantities renders possible.

A New Preparation of Carbon Monoxide.—E. Noack.—Zinc powder heated in a Glaser furnace to 400° reduces carbonic acid to carbon monoxide.—*Ber. d. Deut.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of Water Supplied to London during the year 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
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and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

(Concluded from p. 78).

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Wholesomeness.

In the course of last autumn, the wholesomeness of the water furnished to London by the companies was publicly called in question by the insertion of two or three letters in the *Times*, attacking the character of the supply. The impeachment, though made as usual by writers unentitled to speak with authority, or to claim for themselves any special extent or means of information, seems nevertheless to call for some remark, as expressing the views entertained by a considerable number of persons who are unacquainted with the position in which the question at present stands. The general proposition as to the occurrence from time to time of serious cases of the outbreak and spread of zymotic disease, consequent on the distribution and consumption or impure water, and more especially of water contaminated with excremental matter, is admitted no less freely by those who maintain than by those who impeach the wholesomeness of the London water supply. Indeed, the very resort to chemical analysis as one means among others—and a very important means—of determining the wholesomeness of drinking water, presupposes the unwholesomeness of water more or less contaminated in some particular way; a presupposition which enforces on all concerned in furnishing, controlling, and advising on the supply of water to a community, the obligation of doing their utmost to ensure a wholesome supply and to guard it from every liability to noxious contamination. Starting from this common ground, a certain section of chemists and hygieists, undoubtedly including among their numbers persons alike of acknowledged eminence and capability and of special experience in sanitary questions, have formed an opinion highly unfavourable to the metropolitan supply; the use of which they regard as being at being at all times attended by more or less risk to the several million consumers of the water, and at certain times by a very considerable risk; as, for instance, in November last, when the water distributed by four out of the five companies taking their supply from the Thames was pronounced to be "unfit for drinking" by reason of its amount of "organic impurity." On the other hand, another section of chemists and hygieists, including persons of not less eminence, experience, and independence, have come to the opposite opinion, that no grounds, capable of being sustained by fact and argument, exist for calling in question the wholesomeness of London water, or the freedom from risk attendant on its consumption. If the matter, however, rested here, the public might well have, despite the exceptional healthiness of London among great cities, some cause for uneasiness. But there is the further circumstance to be borne in mind that tribunal after tribunal has had the whole question under consideration,—has heard and inquired into the worst that could be alleged,—and with an unvarying result. The latest inquiry was that of the Royal Commission, who made their report in 1869, the pith of whose conclusion is comprised in the following paragraph from their report:—

"Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the Companies is not generally good and wholesome."

It does not of course follow that the conclusion even of a Royal Commission, agreeing though it does with that of previous tribunals, is necessarily right; but it must at least be admitted to have a strong presumption in its favour. While also it does not follow necessarily that some other capable and impartial tribunal, with the same facts before it, would have arrived at the same conclusion, there is at any rate a strong presumption that it would. And anyhow, it would seem only fit and decorous that those who continue still to attack the quality of London water should make their attacks with some observance of respect for the results of judicial inquiry; and should abstain from imputing ignorance or bad faith to others whose well considered opinion, though different from their own, possesses the advantage of successive decisions in its favour.

But even after the many inquiries that have already been held, it is still open to objectors to make out, if they can, a *primâ facie* case for yet further inquiry. The making out of such a case would seem to hinge upon the possibility of showing either that the condition of things as regards the source of supply, or the condition of knowledge as regards the natural history of zymotic disease, is so different now from what it was in 1869, that conclusions warrantable in 1869 are unwarrantable in the present day. Now, that the condition of things with regard to the source of supply has greatly improved since 1869, does not admit of question. Whether the present condition of knowledge with regard to the natural history of zymotic disease is so different from what the condition was in 1869 as to invalidate the conclusion then formed with regard to the wholesomeness of London water, it is for those who make the contention to show. A mere citation, however, of cases of disease-outbreak, more recent in date but similar in nature to those fully considered in 1869, would avail but little; while the usual appeal to prejudice, by sensational modes of statement and comparison, would serve no more worthy purpose than, in the language of reproof used by the Royal Commission, "to startle those unacquainted with the subject."

We explained in our last annual report how it was "that a small proportion of organic matter, appreciably greater in winter than in summer, occurs as a normal constituent of most river waters; a constituent, however, which, as pointed out by the Commission on Water Supply, there is not any reason to regard as objectionable." It is, of course, not without scientific interest to compare together river-water and spring-water in respect of a constituent which is thus characteristic of the one kind of water, and from which the other kind is relatively free. But it is quite another thing to stigmatise this normal river constituent as "organic impurity" or "organic pollution," and to set up an arbitrary and perfectly individual scale of implied unwholesomeness, based upon the relative proportions of an unobjectionable constituent characteristic of the class of waters it is intended to disparage, and comparatively non-existent in the particular water it is intended to extol. Thus, in the report to the Registrar-General on the quality of the water supply of London during the month of September last, it was pointed out that the "amount of organic impurity" in the waters supplied by the Thames Water Companies was from 2¼ to 3¼ times that found in the water supplied from chalk wells by the Kent Water Company. But to avoid all risk of spoiling the moral, attention was not called to the circumstance that the mean "amount of organic impurity" in the Thames-derived waters was some 33 per cent below that recorded in the same table as existing in the much-vaunted, and deservedly vaunted, Loch Katrine water supplied to Glasgow. To have gone further even than this, and pointed out that, measured by the same standard, the "amount of organic impurity" in the Loch Katrine water was just double that found in the East London Company's water and in the New River Company's water, would have been, indeed, too suggestive of the obvious conclusion that perhaps the ingeniously contrived scale of unwholesomeness, by an appeal to which the water of the London companies is

month after month held up to public execration, is not of any high degree of trustworthiness after all. The circumstance that filtered Thames water, as supplied to London, contains a variable but always minute proportion of organic matter, amounting on the average to less than three-eighths of a grain, and never exceeding three-quarters of a grain per gallon, would be of significant importance only if it could be shown to be an unwholesome constituent of the water. But taking a series of years, and relying solely upon the water analysis supplied to the Registrar-General, it does, with singular perversity, happen that the years in which the metropolitan rate of mortality is exceptionally high are the years in which the "proportion of organic impurity" in the water is relatively low; while the years in which the metropolitan rate of mortality is exceptionally low are the years in which the "proportion of organic impurity" in the water is relatively high—not, of course, because the organic constituent of river water is any more wholesome than it is prejudicial, but most probably because the climatic conditions of the year which affected the rate of mortality in one way affected the proportion of organic matter in an opposite way. In illustration, however, of the occurrence of this inverse relationship, it is noticeable that in the successive years 1869. 1870, and 1871, in each of which there was the exceptionally high mortality of over 24 per thousand, the mean "proportion of organic impurity in Thames water," was represented by the number 912; while in 1872 and the successive years 1880 and 1881, in each of which there was the exceptionally low mortality of considerably less than 22 per thousand, the mean "proportion of organic impurity in Thames water" was represented by the number 1171; the proportion in the year 1868, with its mortality of 23½ per thousand, being represented by the number 1000.

Taking the amount of organic carbon as a measure of the organic matter present in the water, it is worth while to notice within what limits the actual proportions of organic carbon, and consequently of organic matter, are found to range. For the entire nine months preceding November last, the average amount of organic carbon in the water supplied by the Thames companies was, according to our experiments, 0·137 part in 100,000 parts of the water, the highest monthly mean being 0·181 part, and the maximum amount in any one sample out of the entire 154 samples examined, being 0·300 part. Throughout the month of November the river was in a quite exceptional state of flood; and with this flooded state, there was a marked increase in the proportion of organic carbon, so as to give a mean for the month of 0·294 part in 100,000 parts of water, with a maximum in one particular sample, out of the eighteen samples examined, of 0·381 part. Now although the ratio of organic carbon to the organic matter of river water is not positively known, and is doubtless variable within a certain range, it may be taken on a fair approximation to be about 40 per cent. Accordingly, on this assumption, the organic matter in one exceptional sample, out of the 203 samples of Thames water examined by us during the year, fell considerably short of three-quarters of a grain per gallon. The results, published in the report for November, made to the Registrar General, were but a little higher than our own, yet from them was drawn the startling conclusion that the water supplied during the month by four of the Thames companies was so polluted as to be "unfit for drinking," a conclusion which we ventured to challenge in the following terms:—

"In our own previous monthly report we drew attention to the circumstance that, concurrently with the setting in of the winter season, there was, as there customarily is, a notable increase in the proprotion of organic matter present in the water supply. In the report for the same period made to the Registrar-General, attention was also called to this increase; and further, the water distributed by four out of five of the Companies taking their supply from the Thames, was pronounced *ex cathedrâ* to be 'unfit for drinking' by reason of it 'organic impurity.' Now we take upon ourselves to assert that the analytical results set forth in the report, which are not appreciably different from our own, do not afford ground for any such appalling statement; and that the million or more consumers of the water furnished by these stigmatised companies, have not had their health in any way jeopardised by their consumption of the water supplied to them; and that they have not been placed, during the month of November, in any respect in a different position, as regards injury to health, consequent on the character of their drinking-water—admittedly unobjectionable in taste and appearance—from that in which they were placed during the summer months; when, owing to the different conditions of river life and change, the proportion of organic matter in the water, was about one-third or one-fourth of its recent amount—the maximum of which found in any sample, as recorded in the report to the Registrar-General, was under three-quarters of a grain per gallon, or amounted to about the one-thousandth part of one per cent of the reprobated water."

"As bearing on this question, we would recall to mind that the last Royal Commission on Water Supply, after hearing very varied scientific evidence, much of it of the usual alarmist character, reported to the effect that the presence of a small quantity of organic matter in drinking water was not necessarily prejudicial, and that there was not any evidence to satisfy them that the particular organic matter present in filtered Thames water was prejudicial."

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

NITROGEN.

(Concluded from p. 80.)

The ratio directly connecting silver nitrate with ammonium chloride has been determined only by Stas.† The usual method of working was followed; namely, nearly equivalent quantities of the two salts were weighed out, the solutions mixed, and the slight excess of one estimated by titration. In four experiments 100 parts of silver nitrate were found equivalent to chloride of ammonium as follows:—

31·489
31·490
31·487
31·486

Mean 31·488 ± 0·0006

The similar ratio between potassium chloride and silver nitrate has been determined by both Marignac and Stas.

Marignac‡ gives the following weights. I add the quantity of KCl proportional to 100 parts of $AgNO_3$:—

1·849 grm.	KCl =	4·218	$AgNO_3$	43·836
2·473	,,	5·640	,,	43·848
3·317	,,	7·565	,,	43·847
2·926	,,	6·670	,,	43·868
6·191	,,	14·110	,,	43·877
4·351	,,	9·918	,,	42·870

Mean 43·858 ± 0·0044

Stas'‖ results are given in three series, representing silver nitrate from three different sources. In the third

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† "Aronstein's Translation," p. 209.
‡ "Berzellus's Lehrbuch," 5th edition, vol. iii., 1184, 1185.
‖ "Aronstein's Translation," p. 308.

series the nitrate was weighed in vacuo, while for the other series this correction was applied in the usual way. For the KCl equivalent to 100 parts of $AgNO_3$ Stas found:—

First Series.

43·878
43·875
43·875
43·874

Mean 43·8755 ± 0·0005

Second Series.

43·864
43·869
43·876

Mean 43·8697 ± 0·0023

Third Series.

43·894
43·878
43·885

Mean 43·8857 ± 0·0031

Combining all four series we have:—

Marignac	43·858	± 0·0044
Stas, 1st series	43·8755	0·0005
,, 2nd ,, ...	43·8697	0·0023
,, 3rd ,, ...	43·8857	0·0031
General mean	43·8715	± 0·0004

There have also been determined by Penny and by Stas a series of ratios connecting the alkaline chlorides and chlorates with the corresponding nitrates. One of these, relating to the lithium salts, will be studied further on with reference to that metal.

The general method of working upon these ratios is due to Penny.* Applied to the ratio between the chloride and nitrate of potassium it is as follows:— A weighed quantity of the chloride is introduced into a flask which is placed upon its side and connected with a receiver. An excess of pure nitric acid is added, and the transformation is gradually brought about by the aid of heat. Then, upon evaporating to dryness over a sand-bath, the nitrate is brought into weighable form. The liquid in the receiver is also evaporated, and the trace of solid matter which had been mechanically carried over is recovered and also taken into acccount. In another series of experiments the nitrate was taken, and by pure hydrochloric acid converted into chloride; the process being the same. In the following columns of figures I have reduced both series to one standard; namely, so as to express the number of parts of nitrate corresponding to 100 of chloride:—

First Series.—KCl treated with HNO_3.

135·639
135·637
135·640
135·635
135·630
135·640
135·630

Mean 135·636 ± 0·0011

Second Series.—KNO_3 treated with HCl.

135·628
135·635
135·630
135·641
135·630
135·635
135·630

Mean 135·633 ± 0·0011

* *Phil. Trans.*, 1839.

Stas'* results are as follows:—

135·643
135·638
135·647
135·649
135·640
135·645
135·655

Mean 135·6453 ± 0·0014

These figures by Stas represent weighings in the air. Reduced to a vacuum standard this mean really becomes 135·6423.

Now, combining we have:—

Penny 1st series	135·636	± 0·0011
,, 2nd ,, ...	135·633	0·0011
Stas	135·6423	0·0014
General mean ..	135·6363	± 0·0007

By the same general process Penny† determined how much potassium nitrate could be formed from 100 parts of chlorate. He found as follows:—

82·505
82·497
82·498
82·500

Mean 82·500 ± 0·0012

For 100 parts of sodium chlorate he found of nitrate:—

79·875
79·882
79·890

Mean 79·8823 ± 0·0029

For the ratio between the chloride and nitrate of sodium Penny made two sets of estimations as in the case of potassium salts. The subjoined figures give the amount of nitrate equivalent to 100 parts of chloride:

First Series.—NaCl treated with HNO_3.

145·415
145·408
145·420
145·424
145 410
145·418
145·420

Mean 145·4164 ± 0·0015

Second Series.— $NaNO_3$ treated with HCl.

145·419
145·391
145·412
145·415
145·412
145·412

Mean 145·410 ± 0·0026

Stas gives the following series:—

145·453
145·468
145·465
145·469
145·443

Mean after reducing to vacuum standard 145·4526 ± 0·0030

* "Aronstein's Translation," p. 270.
† *Phil. Trans.*, 1839.

Combining, we have as follows:—

Penny, 1st series	145·4164	± 0·0015
,, 2nd ,, ...	145·410	0·0026
Stas	145·4526	0·0030
General mean	145·4185	± 0·0012

We have now, apart from the determinations of gaseous density, nine ratios, representing 114 experiments from which to calculate the atomic weight of nitrogen. Let us first collect and number these ratios:—

(1.)	Ag : $AgNO_3$	:: 100 :	157·479	± 0·0003
(2.)	$AgNO_3$: AgCl	:: 100 :	84·3743	0·0025
(3.)	$AgNO_3$: KCl	:: 100 :	43·8715	0·0004
(4.)	$AgNO_3$: NH_4Cl	:: 100 :	31·488	0·0006
(5.)	Ag : NH_4Cl	:: 100 :	49·597	0·0005
(6.)	KCl : KNO_3	:: 100 :	135·6363	0·0007
(7.)	$KClO_3$: KNO_3	:: 100 :	82·500	0·0012
(8.)	NaCl : $NaNO_3$	:: 100 :	145·4185	0·0012
(9.)	$NaClO_3$: $NaNO_3$	:: 100 :	79·8823	0·0029

From these ratios we are now able to deduce the molecular weight of ammonium chloride and of the three nitrates named in them. For these calculations we may use the already determined atomic weights of silver, oxygen, potassium, sodium, and chlorine, and the molecular weights of silver chloride and sodium chloride. These two molecular weights involve, respectively, the most probable values for silver sodium and chlorine. We cannot, however, appropriately use the directly determined molecular weight of potassium chloride, since the most probable value for the atomic weight of potassium is only in part derived from that salt. The following are the values which we shall employ:—

Ag	= 107·675	± 0·0096
K	39·019	0·012
Na	22·998	0·011
Cl	35·370	0·014
O_3	47·8899	0·0105
AgCl	143·045	0·0108
NaCl	58·3676	0·0052

Now from ratio number five we can get the molecular weight of ammonium chloride, $NH_4Cl = 53·4048 \pm 0·0048$ and $N = 14·0336 \pm 0·0153$.

From ratio number four an independent value for nitrogen can be calculated, viz., $N = 14·0330 \pm 0·015$.

For the molecular weight of silver nitrate three values are deducible, namely:—

From (1)	$AgNO_3$ =	169·5655	± 0·0151
From (2)	,,	169·5362	0·0138
From (3)	,,	169·5612	0·0429
General mean	,,	169·5489	0·0099

Hence $N = 13·9840 \pm 0·0174$.

The molecular weight of potassium nitrate is twice calculable, as follows:—

From (6)	KNO_3 =	100·8985	± 0·0255
From (7)	,,	100·8801	0·0178
General mean	,,	100·8863	0·0146

And $N = 13·9774 \pm 0·0216$.

So also for sodium nitrate we have:—

From (8)	$NaNO_3$ =	84·8773	± 0·0076
From (9)	,,	84·8809	0·0099
General mean	,,	84·8785	0·0060

And $N = 13·9906 \pm 0·0163$.

We have now before us six estimates of the atomic weight of nitrogen. It only remains for us to combine these after the usual method as follows, in order to obtain the most probable value:—

1. From sp. gr. of N	N =	14·0244	± 0·0039
2. ,, ammonium chloride ..	,,	14·0336	0·0153
3. ,, ratio number four ..	,,	14·0330	0·0150
4. ,, silver nitrate	,,	13·9840	0·0174
5. ,, potassium nitrate ..	,,	13·9774	0·0216
6. ,, sodium nitrate	,,	13·9906	0·0163
General mean	,,	14·0210	0·0035

If oxygen is 16, this becomes 14·0291. Stas found N = 14·044. The difference is 0·015, showing a remarkably close agreement.

NOTICES OF BOOKS.

MacIvor's Farmers' Annual. Edited by R. W. EMERSON MACIVOR, F.I.C., F.C.S. Melbourne: Cameron, Lang, and Co.

WE have here an agricultural year-book, specially adapted for the climate of Victoria. First comes a chemico-physiological discussion of the question: How plants grow. Next follows a calendar of farming operations with reference to such crops as arrowroot, tobacco, maize, &c., with which the farmer who has immigrated from England has but a scanty acquaintance. There are instructions on the recognition and treatment of red-rust, the greatest enemy of the Australian wheat-grower. Hop cultivation is described at great length, and recommended in a manner which will disgust the friends of "local option," at home and abroad. Wire-worms have to be provided against, though the species will probably be different from the *Agriotes* of England. Bush fires are judiciously ascribed not to spontaneous combustion, but to the careless use of matches. The remarks on manures are sound, but contain nothing calling for especial comment. Concerning the storage of water there is very valuable advice given, that requisite being not as in England, the farmer's great enemy, but frequently the one thing needed to convert a desert into a garden.

The School of Mines and Industries, Ballaarat, Victoria Australia. Ballaarat Science Lectures, First Series 1882: A Course of Popular Science Lectures, delivered in the Lecture Hall of the School during the Winter of 1882. Published under the Direction of the Council. Ballaarat: James McHutchison.

THIS work begins with an introduction on the use and value of popular science lectures. The writer quotes the memorable saying of Faraday: "Lectures which really teach will never be popular; lectures which are popular will never really teach." He gives us also the more questionable dictum of Samuel Johnson: "You may teach chemistry by lectures, you may teach making shoes by lectures." We should not care to wear such shoes, and of lecture-taught chemistry we see and hear more than is edifying.

The first of the lectures, delivered by Mr. G. Foord, F.I.C., of the Melbourne Royal Mint, discusses alchemy, and gives a very popular, because humorous, history of mediæval chemistry, pharmacy, and medicine. Peter Wolfe, the well-known inventor of Wolfe's bottles, who died in 1805, is mentioned as the last of the alchemists. Of this we are by no means sure. There appeared in the *Athenæum*, between the years 1840-50, a strange advertisement offering to teach the "hermetic art" for a consideration. We have heard, too, that even at the present day one of the fraternity exists in London, but we have never met with him in person.

The second lecture of the Course, on the "Wonders of Coral Life," was delivered by the Rev. T. E. Ick. Prof. R. L. J. Ellery, F.R.S., the Astronomer Royal for Victoria, lectured on the "Sun's Distances and the Transits of

Venus." Mr. W. J. Thomas discoursed on the "Earth as a Planet." His lecture may do good service if the vagaries of "zetetic astronomy" have penetrated to Australia. On a subsequent occasion the same lecturer took for his subject the "Stellar Universe." Dr. J. F. Usher discussed the "Human Body and Bones," concluding singularly enough with strictures on the "rank atheism, thinly veiled," of Prof. Tyndall's Belfast Address.

Baron F. von Müller, F.R.S., the Government Botanist, delivered a most interesting lecture on the "Flora of Australia." Prof. M. Smith took for his subject "Gold," and the concluding lecture of the Course, on the "Volcanic Rocks of the Ballaarat District," was given by his colleague, Prof. F. M. Krause.

The School of Mines, Ballaarat. Annual Report presented at the Meeting of Governors held Jan. 19, 1882. Published by Authority, School of Mines, Lydiard St., February 12, 1883.

The Ballaarat School of Mines is of somewhat complex character. In addition to mining, metallurgy, engineering, &c., it gives instructions in pharmaceutical chemistry. Its professorial staff is not numerous:—Mr. A. M. Smith, B.Sc., occupies the chairs of chemistry (inorganic, organic, technical, and pharmaceutical), of physics in all its branches, of botany, and of metallurgy; Mr. F. M. Krause teaches geology, mineralogy, scientific mining, surveying in all its branches, and is in addition curator of the museum. We hope that the remuneration of these gentlemen bears a fair proportion to the very heavy duties devolving upon them. In the annual report the value of the operations of the School and the necessity for increased support from the public are very ably enforced.

We learn that the metallurgical laboratory is now fitted with twelve melting furnaces, three cupellation furnaces, and one blast-furnace. The students are supplied with fuel, pots, fluxes, and all other requisites free of any charge beyond the ordinary Term Fee. A Field Club has also been established for the purpose of outdoor study in geology, mineralogy, &c. It was proposed to found classes in agricultural chemistry, but, we regret to learn, without any practical results. A course of four public lectures has been delivered by Prof. Smith on bleaching and dyeing, and on the manufacture of soda and sulphuric acid. During the winter of 1882, a course of popular lectures have been delivered on various scientific subjects. Several important additions have been made to the museum, but the curator complains that the objects in every department are now far too crowded for convenient and instructive exhibition, and additional space and light have become matter of absolute necessity. We can only hope that the requisite funds will be forthcoming.

CORRESPONDENCE.

YELLOW HYDROCHLORIC ACID.

To the Editor of the Chemical News.

Sir,—In "A Treatise on Chemistry," by H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. (New Edition, 1881), at page 136 it is stated that the aqueous hydrochloric acid obtained in the manufacture of soda-ash is "usually of a yellow colour, due to organic matter," and, in the list of its impurities, iron is not mentioned. In "Miller's Elements of Chemistry" (1868), at page 124, it is said that "Commercial hydrochloric acid is liable to be contaminated with iron, which gives it a yellow colour."

As I fancied that I had acquired, in my humble way, some knowledge of this important chemical, I experienced a shock of mental earthquake on reading the former statement. For consolation, I immediately had recourse to the bottle—of yellow hydrochloric acid—with which I made the following experiments:—

(1.) A small fragment of zinc bleached it at once, and chlorine-water restored the yellow colour.

(2.) After dilution with water it gave a dark blue with potassium ferrocyanide.

(3.) Potassium ferridcyanide gave no blue colour until the acid had been decolourised by zinc.

(4.) Potassium sulphocyanide gave a strong pink colour with the diluted acid.

(5.) Ammonia in excess and ammonium sulphide gave a dark green precipitate, which dissolved in HCl, and gave a dark blue with potassium ferridcyanide.

On adding a little ferric chloride to colourless hydrochloric acid the same yellow shade was obtained, and the liquid gave the same reactions as the commercial yellow acid.

My own equanimity being thus restored, I hope you will kindly allow me to preserve others from the shock experienced by—

A Practical Chemist.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 6, August 6, 1883.

Reclamation of Priority with Reference to a Communication by M. Jamin on the Critical Point of Liquefied Gases.—W. Ramsay.—The author shows that the principal points in M. Jamin's memoir on the critical point of liquefied gases had been anticipated in his (Mr. Ramsay's) communication found in the *Proceedings of the Royal Society*, April 22 and December 16, 1880.

Application of Ampère's Method to the Discovery of the Elementary Law of Electric Induction by Variation of Intensity.—M. Quet.

Measurement of Differences of Potential by means of the Galvanometer.—L. Thévenin.—These two mathematical papers do not admit of useful abstraction.

Boron.—A. Joly.—The author summarises the results of Sainte-Claire Deville and of Hampe, points out their discrepancies, and shows that the respective analyses of Sainte-Claire Deville and Wœhler, and of Hampe, have been made upon different products. He distinguishes among the products formed on the reduction of boric acid by aluminium: A boride, $BoAl$, in hexagonal lamellæ of a golden yellow, which has been studied by Deville and Wœhler; a boride, Bo_6Al, in large black lamellary crystals; quadratic yellow crystals of a fine adamantine lustre, containing carbon and aluminium; a boron carbide, or probably several carbides, derived from the transformation of the preceding compounds at an elevated temperature, in presence of carbon and boric acid in excess.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 1.

History of the Meta-nitriles.—O. Wallach.—A polemical paper directed against H. W. Städel.

The Primary and Secondary Naphthylamines.—G. Benz.—The author treats of the action of ammoniacal calcium chloride upon β-naphthol and α-naphthol; the behaviour of the same two bodies with ammoniacal zinc chloride; the production of α- and β-dinaphthylamines by the action of dehydrating agents upon mono-naphthols and mono-naphthylamines; and the picrates and acetyl derivatives of the secondary naphthylamines.

Derivatives of Brom-acetophon and Aceto-phenon.—W. Städel.—Not adapted for abstraction.

Phenacyl-ethyl-anilide.—A. Weller.—The author has studied the base obtained by the reaction of brom-aceto-phenon upon diethyl-aniline. He describes it as insoluble in water, sparingly soluble in alcohol, more readily in ether, benzol, and carbon disulphide. It melts at from 94° to 95°. It dissolves easily and readily in hydrochloric acid, and is partially precipitated on the addition of water.

Hydrobromates and Hydriodates of Aromatic Bases.—W. Städel.—A description of the ortho-toluidine hydrobromate, toluidine hydriodate, and the corresponding para-compounds. Xylidine hydrobromate, meta-chlor-aniline hydrobromate, the corresponding para-compound, meta-nitro-aniline hydrobromate, and meta-phenetidine hydrobromate. All these compounds, except the salts of para-toluidine and meta-nitro-aniline, crystallise very readily; their solutions have an acid reaction, and they take up large quantities of the free bases without losing the acid reaction.

Methylation and Ethylation of Aniline and Toluidine.—H. Reinhardt and W. Städel,—An account of mono-methyl-aniline, dimethyl-aniline, mono-ethyl-aniline, diethyl-aniline, mono-methyl-ortho-toluidine, dimethyl-ortho-toluidine, and the corresponding para-compounds.

Nitro-ethyl-aniline.—A. Weller.—A preliminary communication. The author obtains this compound by treating ethyl-acetanilide with an excess of cold nitric acid, sp. gr. 1·52, under refrigeration.

Dimethyl-xylidines, Dimethyl-meta-chlor-aniline, and Dimethyl-meta-phenetidine.—H. vom Baur and W. Städel.—A preliminary communication, in which the two last mentioned bodies are briefly described.

Ortho-nitro-cinnamyl-acet-acetic Ether.—E. Fischer and H. Kuzel.—The authors have studied the formation of ortho-nitro-cinnamyl-acetone and ortho-nitro-cinnamyl-methyl-ketone.

Formation-heat of the Chlorine Compounds of Phosphorus and Arsenic.—Julius Thomsen.

Formation-heat of the Chlorides and Oxides of Antimony and Bismuth.—Julius Thomsen.—These two papers give important thermo-chemical data in a tabular form.

Synthesis of α-Naphthol.—R. Fittig and H. Erdmann.—The authors obtain this compound by distilling lactonic acid.

The Occurrence of Coniferine in the Lignified Tissues of the Sugar Beet.—E. O. von Lippmann.—The nature of this paper appears sufficiently from the title.

The Action of Iodine upon Mono- and Di-nitro-diphenyl-thio-carbamide.—S. M. Losanitsch.—By this reaction the author obtained a mixture from which he has separated nitraniline, phenyl myrosine, meta-nitro-phenyl-mono-thio-urethan, and meta nitro-triphenyl-guanidine. The two latter of these compounds are here described.

The Oxidation of the Nitro-toluoles with Potassium Ferricyanide.—W. A. Noyes.—Ortho- and nitro-toluoles are oxidised in this manner, just as by alkaline permanganate.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Corrosion of Boilers.—In the *Times* of August 20th occurs a paragraph reporting the meeting of the French Association for the Advancement of Science at Rouen. Therein a paper is mentioned on the "Corrosion of Boiler Plates and the Use of Zinc Plates to Prevent the same." Could any of your readers oblige with references to the right source for a full report of this paper?—Old Subscribers.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

SESSION 1883-84.

I. Department of Arts and Law.
II. Department of Science and Engineering.

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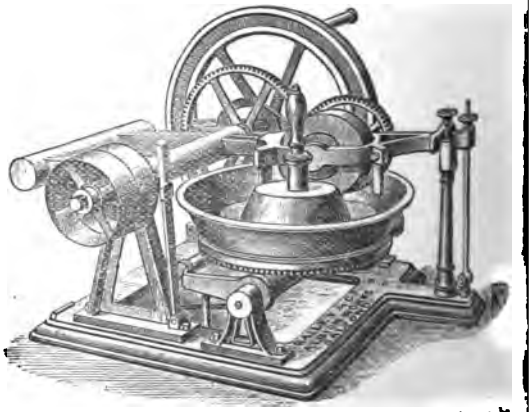

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1240.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XII.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(95.) *On Antimony Pentiodide.* By J. H. PENDLETON, of Louisa Courthouse, Virginia.

Two or three years ago Mr. F. Hampton, then a student in this laboratory, obtained evidence of the existence of an instable pentiodide of phosphorus,* and more recently Mr. B. E. Sloan, also working here, reached the same result in regard to pentiodide of arsenic.† Mr. Pendleton has examined into the possibility of forming a parallel compound of iodine with antimony.

Carefully purified metallic antimony was fused with an excess of pure iodine, in an atmosphere of an inert gas, in a sealed tube kept at a temperature above the fusing-point of the mixture for an hour or two. The end of the tube containing the material was then heated, in a bath of sulphuric acid, to various temperatures and for various lengths of time in successive experiments, while the other end was kept cold by ice-water, and served to collect the surplus iodine distilled off. The tube having been cooled down and opened, the residual material was submitted to analysis, the iodine being determined with the aid of sodium thiosulphate, and the antimony as tetroxide after careful treatment with nitric acid.

When the heating-bath had been kept at a temperature not exceeding 130° C., the residue gave results corresponding pretty closely to the formula SbI_5, and consisted of a homogeneous mass, of crystalline structure, and dark brown colour, distinctly different in appearance from the red tri-iodide, decomposable by water or on prolonged exposure to moist air. The fusing-point was between 78° and 79° C., notably lower than that of either the tri-iodide, or free iodine, and agreeing in this relation with what had been observed by Mr. Sloan for the corresponding compound of arsenic. Antimony pent-iodide is, however, a very unstable substance, readily undergoing partial dissociation by exposure to moderate increase of temperature. In this respect, also, it forms a parallel to the pent-iodides of arsenic and phosphorus.

(96.) *On the Condensation to Liquid Form of Nitrogen Trioxide.* By R. H. GAINES, of Mossingford, Virginia.

It has often been stated, in reference to the surface condensation of gases by porous solids, that in some cases at least the gas is very probably brought to the liquid state in the pores in which it accumulates. Some of these statements were apparently made before Andrew's "critical-point" of temperature had been studied, and have been repeated without due consideration of its bearing upon the impossibility of liquefying certain gases at common temperatures by any mere diminution of volume. It seems possible, however, that the liquefaction of a gas, the "critical-point" of which was not too low, by absorption into the pores of an inert solid, might be rendered visible if the colour of the substance were not the same in the gaseous and liquid states. Such a case for experiment appeared to be presented by nitrogen trioxide, orange in the former, but blue in the latter state, assuming that the identity of the substance is preserved in passing from the one to the other.

Mr. Gaines prepared crude nitrogen trioxide by heating nitric acid with arsenious oxide, drying the orange mixture of gases by passage over calcium chloride, and condensing by a freezing mixture. From the dark green liquid so obtained purer N_2O_3 was produced by gently warming the liquid, passing through it a current of nitrogen dioxide (from nitric acid and ferrous sulphate), conducting the gaseous mixture through a coil of heated glass tube, and thoroughly drying the product by two long calcium chloride tubes and a tube of phosphorus pentoxide. A still better, apparently quite pure, product was obtained by condensing by a freezing mixture the material derived from this last process, and using it as the starting-point for a repetition of the same method, employing carefully purified and dried nitrogen dioxide. Finally, the pure N_2O_3 in gaseous form was carried in succession through three condensing tubes immersed in the same cooling bath and maintained at the same temperature. The first and last of these were empty; the intermediate one contained light gray spongy platinum.* Gradually lowering the temperature of the bath containing these tubes, it was repeatedly found that condensation to a dark coloured liquid occurred simultaneously in all three, no difference being observed in the case of the spongy platinum when care had been taken to dry it thoroughly beforehand. In a first experiment, in which this precaution was omitted, a blue colour developed on the platinum before condensation had occurred in the empty tubes.

While the main result looked for was thus simply a negative one, two points observed in connection with it are worth recording.

In the first place, nitrogen trioxide has been generally described as a blue liquid. Hasenbach† states that at ordinary temperatures it is dark blue, changing at −10° C. to a splendid indigo-blue. The liquid obtained by Mr. Gaines in its purest state had a dark *green* colour, but this changed to blue on addition of a very little water. When only a very small portion had become blue this (nitrous acid?) did not readily mix with the remainder, which was still green.

In the second place, although there do not seem to be exact observations on record as to the temperature at which liquefaction of nitrogen trioxide occurs under ordinary pressure, the directions of the text-books with respect to the freezing mixtures to be used seem to imply that quite a low temperature is necessary. Mr. Gaines, in several experiments, and using different specimens of the trioxide, observed uniformly +14·4° C. as the temperature of condensation under a pressure of 755 m.m. When the liquid so obtained was heated, ebullition began—whether splitting-up be supposed to occur or not—at just the same temperature.

(97.) *Unsuccessful Attempts to Prepare a Carbonyl Iodide analogous to Phosgene.* By S. P. COWARDINS, of Richmond, Virginia.

A number of experiments were tried with a view to preparing the compound COI_2. The chief of these may be briefly mentioned, though none led to the desired result.

Dry carbon monoxide and iodine in the proper proportions were introduced into a large flask, which was hermetically sealed, and exposed day after day to the light—much of the time to the direct rays of the sun when quite bright. After two months there was no apparent change.

Carbon monoxide was dried and passed through a bulb containing iodine. The bulb was heated, and the mixture of gas and vapour was passed on to condensing tubes

* CHEMICAL NEWS, vol. xlii., p. 180.
† *Ibid.*, vol. xliv., p. 194.

* Asbestos and other porous materials were also tried, but with no difference of result.
† *Jour. f. Prak. Chem.* [2], iv., 1.

surrounded by ice and salt. Iodine condensed unchanged in the tubes, and carbon monoxide escaped unchanged.

The last experiment was repeated, interposing a coil of strongly heated glass tube between the iodine bulb and the condensing tubes: the result was as before.

Carbon monoxide was passed through heated arsenic pentiodide, and thence on to the condensing apparatus. The pentiodide of arsenic was partly reduced to tri-iodide (as it would have been by dissociation if heated alone), iodine condensed in the tubes, and carbon monoxide escaped.

Carbon monoxide was heated, and passed over red-hot iodide of lead, with no detectable effect.

Carbonyl chloride was prepared—in one case by the action of carbon monoxide on antimony penta-chloride, in another by passing carbon monoxide and chlorine through heated animal charcoal—and was then carried over potassium iodide, and so on to the condensing tubes. The potassium iodide was partially decomposed, but iodine alone was condensed, and carbon monoxide escaped. A little chloride of iodine was also observed to be formed.

Several of these experiments were repeated with modifications in detail, but with no result worthy of record.

(98.) *Analysis of Gibbsite, from Marianna, Province of Minas Geraes, Brazil.* By W. C. EUSTIS, of Washington, D.C.

The specimen examined—from a locality in Brazil not heretofore mentioned, as far as I have seen—was given me by Prof. Orville A. Derby, Director of the Section of Mineralogy and Geology in the National Museum, Rio de Janeiro. It seemed to represent a small seam or vein in talcose slate, for the most part nearly pure, but associated on the outside with a little crust of oxide of iron.

The mineral was greyish white to nearly colourless, with sub-vitreous lustre, tending towards silky in some places. The surface was mammillary, and the structure radiate or fibrous. Hardness = 3. Specific gravity = 2·4. Whitened before the blowpipe flame, losing water, but did not fuse. Analysis gave—

Al_2O_3	63·81
H_2O	35·85
Fe_2O_3	0·49
CaO	0·30
MgO	0·03
SiO_2	0·20
	100·68

These figures agree well with the formula of the trihydrate, $Al(HO)_3$.

Aluminium phosphate was carefully tested for, but none was present. The dark coloured incrustation on the outside contained, beside iron, a little manganese and traces of cobalt and nickel.

(99.) *Analysis of a Native Ferrous and Aluminic Sulphate, from Tepeji, State of Mexico, Mexico.* By T. P. LIPPITT, of Charlestown, West Virginia.

This mineral was sent me by Prof. Mariano Bárcena, of the City of Mexico. Its physical characters had been described by him, but its chemical composition had not been examined.

The specimen consisted of a compact mass of delicate silky fibres, parallel and adherent, but easily detachable from each other, like those of asbestos. The fibres were flexible to a considerable extent. Colour pale greenish white. Lustre silky and shining. Hardness = 2. Specific gravity = 1·89 (taken in benzene). Soluble in water. Gave off acid water on being heated in a glass tube. A little gysum occurred intermixed with the pure mineral, which otherwise seemed under the microscope to be perfectly homogeneous. This foreign substance was removed as far as possible, and the purified material gave on analysis—

Fe"	7·81
Al	4·92
Ca	0·52
SO_4	41·59
H_2O	43·60
	98·44

The iron proved to exist altogether in the ferrous condition. Subtracting the constituents of gypsum corresponding to the small amount of calcium found, these figures represent a salt of the empirical formula—

$$Fe''_3Al_4(SO_4)_9(H_2O)_5,$$

equivalent to two molecules of halotrichite *plus* one of melantrite:—

$$2\left\{Fe''Al_2(SO_4)_4.(H_2O)_{22}\right\} + Fe''SO_4.(H_2O)_7.$$

(To be continued.)

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.—CURCUMIN.

By C. LORING JACKSON and A. E. MENKE.

THE following paper* contains a description of our experiments on the action of nascent hydrogen and of bromine upon curcumin.

Action of Nascent Hydrogen.

Dihydride of Curcumin, $C_{14}H_{16}O_4$.—This substance was made by the action of sodium amalgam and water upon circumin. The best result was obtained when a mixture of circumin, dilute alcohol, and strong sodium amalgam was allowed to stand for somewhat more than a week. The alcohol, though not absolutely necessary, as the sodic hydrate formed gradually brings the curcumin into solution, accelerates the action, which at best is extremely slow. After the dark red colour of the sodic salt of curcumin had give place to a blackish tinge, the liquid was poured off from the mercury, acidified with hydrochloric acid, the fawn-coloured precipitate thus obtained washed till free from acid, and dried *in vacuo*. A combustion gave the following results:—

0·2290 grm. of subatance gave 0·5678 grm. of CO_2 and 0·1312 grm. of H_2O.

	Calculated for $C_{14}H_{16}O_4$	Found.
Carbon	67·74	67·63
Hydrogen	6·49	6·36

Properties.—It forms a brownish-white powder, melting in the neighbourhood of 100°, but with no definite melting-point; it is insoluble in water, freely soluble in alcohol and glacial acetic acid, slightly in ether, and insoluble in ligroine and benzol. Strong sulphuric acid dissolves it with a reddish-brown colour, very different from the purple produced by curcumin. Sodic hydrate dissolves it on warming, and so does sodic carbonate; but the latter solution becomes turbid, and throws down a brownish precipitate on cooling.

The addition of hydrogen to curcumin by sodium amalgam and dilute alcohol is a tedious process, occupying more than a week and giving a very bad yield, the product being frequently accompanied by a viscous substance, probably formed by the action of air on the alkaline solution of the hydride. A much better method of adding hydrogen to curcumin consisted in treating it with zinc dust and acetic acid, although in this case the hydride at first produced was further modified in the course of the reaction.

Anhydride of Curcumin Dihydride $(C_{14}H_{15}O_4)_2O$.—Curcumin was warmed with acetic acid of 85 per cent and a large quantity of zinc dust, the temperature being kept

* See previous article, CHEMICAL NEWS, vol. xlvi., p. 61.

elow the boiling-point of the acetic acid. After some hours the yellow colour of the solution had become replaced by a dark brown, and if then a little of the substance gave a yellow instead of a red colour with sodic hydrate, the heating was discontinued, and the liquid filtered into water, which precipitated fawn-coloured flocks similar to those of the preceding compound. After we had satisfied ourselves that it was impossible to crystallise the substance, we purified it by re-solution in glacial acetic acid and precipitation with water; but even this treatment did not remove the whole of the zinc salt, as was shown by the appearance of a slight ash on combustion. This has been subtracted from the weight of the substance taken in calculating the percentages.

The same substance was obtained when curcumin was heated with zinc dust and a solution of ammonic hydrate. The combustion marked III. was of a product made in this way:—

The substance after thorough washing with water was in each case dried on a steam radiator at a temperature of about 60°.

I. 0·2552 grm. of substance gave 0·6460 grm. of CO_2. 0·1476 grm. of H_2O. Ash = 0·004.

II. 0·2449 grm. of substance gave 0·6183 grm. of CO_2. 0·1368 grm. H_2O. Ash = 0·0061.

III. 0·2357 grm. of substance gave 0·6001 grm. of CO_2. 0·1365 grm. of H_2O. Ash = 9·002.

	Calculated for $C_{28}H_{30}O_7$.	Found.		
		I.	II.	III.
Carbon	70·42	70·14*	70·61*	70·03*
Hydrogen ..	6·25	6·53	6·36	6·48

Properties.—It resembles the dihydride closely, like it forming a dirty white powder, with no definite melting-point, since it melts gradually in the neighbourhood of 120°. The best solvents for it are alcohol and glacial acetic acid, but it is deposited on evaporation of the solvent as a varnish. It is essentially insoluble in ether, ligroine, and benzol, slightly soluble in chloroform. A solution of potassic hydrate dissolves it with a yellow colour, while potassic carbonate forms a dark brown solution if boiled with it, but as this solution cools, brownish flocks are deposited, which we supposed to be a potassium salt, until two analyses of the substance showed that it did not contain more than 2·5 per cent of potassium, whereas the salt with the least possible amount of the metal contains 7·5 per cent. It is evident, therefore, that the potassium was an impurity, which could well be, since we were able to find no satisfactory method of purification. An attempt to make a potassium salt with alcoholic potassic hydrate gave a black liquid, insoluble in a mixture of alcohol and ether, and of the most unpromising appearance.

The fact that the substance forms no salt with potassic carbonate indicates that the two molecules of the dihydride are connected by the removal of water from their carboxyl groups; but we did not consider the nature of the substance satisfactorily explained until we succeeded in making it from the dihydride, $C_{14}H_{16}O_4$, by the action of an acetic acid solution of zincic acetate. After warming the two substances together for some time, the product was treated with water, and the precipitate washed, dried, and analysed, with the following result:

0·1430 grm. of substance gave 0·3666 grm. of CO_2 and 0·0868 grm. H_2O.

	Calculated for $C_{28}H_{30}O_7$.	Found.
Carbon	70·42	69·92
Hydrogen	6·25	6·68

Whereas before this treatment a portion of the same sample gave carbon 67·63, hydrogen 6·36, as above. This experiment proves, therefore, that the nascent hydrogen given off by zinc dust and acetic acid first converts the curcumin into the dihydride, from which the zincic acetate afterwards removes one molecule of water. The anhydride is broken up only incompletely by the action of water at high temperatures or by boiling with sodic hydrate, the product in each case being a mixture of the dihydride and anhydride.

In order to study the oxidation of the dihydride, some diethyl-curcumin, prepared according to the method given in our first paper, was treated with zinc dust and acetic acid. The product thus obtained gave the following results on analysis, which indicate that it is a mixture of di- and mono-ethyl-curcumin dihydride:—

I. 0·2130 grm. of substance gave 0·5484 grm. of CO_2 and 0·1415 grm. of H_2O. Ash 0·0004.

II. 0·1938 grm. of substance gave 0·4986 grm. of CO_2 and 0·1336 grm. of H_2O.

	Calculated for $(C_2H_5)C_{14}H_{18}O_4$.	Found. I.	Found. II.	Calculated for $(C_2H_5)_2C_{14}H_{18}O_4$.
Carbon	69·59	70·35	70·15	71·05
Hydrogen.. ..	7·25	7·40	7·66	7·89

Some of this substance was mixed with a saturated neutral solution of potassic permanganate and allowed to stand at the ordinary temperature. The oxidation took place very slowly, several weeks' standing being necessary to complete the reaction. The principal product, was proved by its melting-point to be ethyl-vanillic acid, while the presence of a small quantity of ethyl-vanillin was indicated by its characteristic smell.

The most striking fact in connection with this reaction was that the dihydride was oxidised with much more difficulty than curcumin itself.

Action of Bromine on the Anhydride of Curcumin Dihydride.—When the hydride, dissolved in glacial acetic acid, was mixed with an excess of bromine and allowed to stand over night, the liquid turned black, and upon addition of water, a red precipitate was thrown down, which was washed with water, dried, and analysed:

I. 0·6652 grm. of substance gave 0·7160 grm. of CO_2 and 0·1122 grm. of H_2O. 0·3100 grm. gave according to Carius 0·4125 grm. of AgBr.

II. 0·3202 grm. gave 0·3498 grm. of CO_2 and 0·0562 grm. of H_2O. 0·2786 grm. gave 0·3730 grm. of AgBr.

	Calculated for $C_{14}H_{10}Br_4O_4$.	Found. I.	Found. II.
Carbon	29·89	29·36	29·80
Hydrogen ..	1·78	1·87	1·95
Bromine.. ..	56·94	56·62	56·99

The substance is red and amorphous; it does not melt under a red-heat, but seems to be decomposed without melting. It is insoluble in water, ligroine, and benzol, very slightly soluble in alcohol and ether, soluble in glacial acetic acid. Strong sulphuric acid has no action upon it. It is vigorously acted on by boiling potassic hydrate, forming a red solution from which acids precipitate a black tarry body which we were unable to purify; two analyses of its sodium salt, however, showed that it contained about the same percentage of oxygen as of carbon, and that most of the bromine (all but 7 per cent) had been removed, proving that the bromine in the original substance is all in the side chain.

Action of Bromine on Curcumin.

We have obtained two bromine compounds of curcumin, one containing four and the other seven atoms of bromine.

Tetrabromide of Curcumin, $C_{14}H_{14}Br_4O_4$.—When curcumin suspended in carbonic disulphide is allowed to stand with an excess of bromine for some hours, it is converted into a white substance, which is left as the carbonic disulphide evaporates. The carbonic disulphide can be replaced by glacial acetic acid, but in this case an excess of bromine or the use of a large quantity of glacial acetic acid must be avoided. The nature of this body

* If the ash is not subtracted the percentages are—

I.	II.	III.
69·04	68·85	60 44
6·43	6·20	6·43

could not be established satisfactorily by analysis, as it was more or less decomposed by all its solvents, and therefore a thorough purification was impossible; we have obtained one fair analysis, however, of a sample washed with carbonic disulphide.

0·2375 grm. of substance gave according to Carius 0·3180 grm. of AgBr.

	Calculated for $C_{14}H_{14}Br_4O_4$.	Found.
Bromine	56·66	56·99

Other specimens contained the fcllowing percentages :—

Bromine	54·87	58·51	58·57

To confirm this result, which points to the taking up of four atoms of bromine, we determined the increase of weight caused by the bromine. For this purpose carbonic disulphide and bromine in excess were added to a weighed amount of curcumin, and the product weighed after drying it a little below 100°.

I. 0·252 grm. of curcumin gained 0·354 grm.

II. 0·218 grm. gained 0·300 grm.

These results correspond to the following percentag e of bromine in the product :—

	Calculated for $C_{14}H_{14}Br_4O_4$.	Found. I.	Found. II.
Bromine	56·66	58·41	57·91

And there is therefore no doubt that the substance contains four atoms of bromine. To decide whether it was an addition or substitution product, we determined the amount of hydrobromic acid given off, as in every preparation an evolution of this gas was observed. For this purpose the gases formed in the reaction were allowed to pass through water, and finally the carbonic disulphide and excess of bromine were removed, at first from the curcumin, and afterward from the absorbing water, by a stream of air; the hydrobromic acid collected in the water was then determined as argentic bromide. One grm. of curcumin was used in each case, and in the following comparison of results the amounts found are compared with the calculated amount if the curcumin had given off two molecules of hydrobromic acid :—

Two Molecules HBr.	I:	II.
0·66	0·185	0·28

From this it appears that the hydrobromic acid is produced by an insignificant secondary reaction, and that the substance is an addition product, and therefore has the formula $C_{14}H_{14}Br_4O_4$.* We may add that some experiments to determine directly the number of molecules of bromine added pointed to two molecules as the probable amount, but the results are not definite enough to make them worth publishing.

Properties.—It is a white or whitish amorphous substance, melting in the neighbourhood of 185° with decomposition, but it has no definite melting-point. It is insoluble in water, soluble with decomposition in alcohol and in glacial acetic acid, which acts upon it, however, less rapidly than the alcohol, very slightly soluble in ether, chloroform, and carbonic disulphide, insoluble in ligrone and benzol. Its behaviour with various reagents was taken up, but no results were obtained which promised to repay further study. The following observations, however, are of some interest. Potassic hydrate and also argentic oxide convert it in part into vanillin, to judge from the smell, while both anilin and zinc cleaned with sulphuric acid act upon it, the former with considerable evolution of heat,—thus confirming the inference that it is an addition product. The principal products from these reactions, as well as those from the action of sodic carbonate and water, and of reducing agents, are ill-defined bodies which we could find no means of purifying.

* The high percentages of bromine obtained in the analyses may be accounted for by this secondary reaction.

Pentabrom-curcumin-dibromide, $C_{14}H_9Br_7O_4$.—If curcumin in glacial acetic acid is treated with an excess of bromine, or the solid tetrabromide treated with bromine, a red substance is formed, which, after washing with water and drying *in vacuo*, gave the following results :—

0·2898 grm. of substance gave 0·2230 grm. of CO_2 and 0·0304 grm. of H_2O.

0·2666 grm. of substance gave according to Carius 0·9323 grm. of AgBr.

	Calculated for $C_{14}H_9Br_7O_4$.	Found.
Carbon	20·97	20·98
Hydrogen	1·12	1·16
Bromine	69·91	69·02

Properties.—A red amorphous substance melting near 120°, but without definite melting-point; insoluble in water, soluble in alcohol apparently with decomposition, easily soluble in ether and glacial acetic acid, leaving a varnish, slightly soluble in benzol, insoluble in ligroine. Strong sulphuric acid acts on it very slowly, finally turning it a more brilliant red. Our study of the behaviour of this substance has led to no more definite results than in the case of the tetrabromide.

Heated alone, it gives off bromine and hydrobromic acid, leaving a black tar, from which a yellow substance containing bromine can be extracted by alcohol; we may study this experiment more carefully hereafter. Sodic hydrate, sodic carbonate and water, sodic alcoholate, and argentic oxide all act upon it, but no smell of vanillin was observed in any case. The same is true of several oxidation experiments we have tried upon it, and this would seem to indicate the presence of a portion of the bromine in the benzol ring. It is an interesting fact that potassic dichromate and sulphuric acid, and also neutral potassic permanganate, attack this substance only with extreme difficulty, whereas they both act vigorously on curcumin.

Summary.

1. Curcumin takes up two atoms of hydrogen when treated with nascent hydrogen.
2. The dihydride thus formed passes over easily into an anhydride by losing one molecule of water.
3. The anhydride of diethyl-curcumin dihydride is much less easily attacked by oxidising agents than diethyl-curcumin, but the products are the same—ethylvanillic acid with a trace of ethylvanillin.
4. Bromine removes two atoms of hydrogen from the dihydride, and replaces four more, forming $C_{14}H_{10}Br_8O_4$.
5. Only four atoms of bromine can be added to curcumin.
6. The tetrabromide has a great tendency to form vanillin when treated with substances which remove bromine.
7. With an excess of bromine a substance, $C_{14}H_9Br_7O_4$, is formed.
8. The pentabrom-curcumin-dibromide is oxidised in neutral or acid solutions only with great difficulty.

The observations just described throw some light upon the nature of the side-chain of curcumin, but as the inferences to be drawn from them are at best extremely doubtful, we shall postpone all discussion of the structure of curcumin until our further study of it has put the subject on a more secure basis.—*Amer. Chem. Journ.*

Nickel Crucibles.—M. Mèrmet recommends the use of nickel crucibles instead of silver, in chemical manipulations. They are slightly attacked, it is true, by melted potash, but silver itself is not indifferent to this action. They cost at first much less than silver, and moreover they have the great advantage of melting at a higher temperature. It often happens, in fact, that inexperienced chemists melt their silver crucibles in heating them over a gas lamp; such an accident is not to be feared with nickel crucibles.—*Chron. Industr.*

ON COPPER SULPHIDE IN A COLLOIDAL CONDITION.

By W. SPRING.

H. Schulze has recently published in the *Journal für Prakt. Chemie* an interesting memoir on soluble antimony *trisulphide* in which it is said that perhaps other sulphides will prove to be soluble. The author having to prepare pure sulphides and oxides which were needed in an investigation with which he is engaged, had opportunity to observe that several of these bodies can easily be obtained in a colloidal state. The observations of Schulze concerning the solubility of antimony and arsenic trisulphide in pure water completely agree with the author's results.

He finds further that copper sulphide is readily and completely soluble in pure water on proceeding as follows :—

A dilute solution of copper sulphate in ammonia is treated with a current of sulphuretted hydrogen until all the copper is thrown down as sulphide. The black precipitate is then washed by decantation for some weeks with sulphuretted hydrogen-water. As soon as ammonium sulphate or hydrosulphate is no longer present in the washings the sulphide passes gradually into solution and there is ultimately obtained a black liquid with a slight greenish fluorescence. This black liquid passes like water through a filter. On examining it in a stratum of 2 c.m. in depth the colour appears brown, and the presence of suspended copper sulphide cannot be admitted, the solution is clear. This solution can be boiled without decomposition, and if gently evaporated on the water-bath the sulphide is left as a black varnish. Small quantities of solutions of salts quickly cause the black liquid to coagulate especially in heat.

Precipitated copper sulphide which is thus readily taken up by water in the colloidal state loses this property even if dried in a vacuum at common temperatures. The author adds that the pure, dry, copper sulphide thus obtained is not black, as generally asserted, but a fine dark green. If submitted to a pressure of 6500 atmospheres it forms blocks of a deep blue, metallic lustre.

Manganese peroxide obtained by treating manganous hydroxide with hypochlorous acid, passes, when perfectly washed, into a deep brown solution.

The behaviour of antimony trioxide, tin oxide, and tin sulphide, is similar.

The author has obtained more than 50 grms. of this body as a reddish-brown, transparent, vitreous mass by evaporation in a vacuum over sulphuric acid.—*Berichte der Deutsch. Chem. Gesell.*

NEW METHOD FOR THE DETERMINATION OF NITROGEN.

By J. KJELDAHL

The author shows the desirability of a process for effecting the determination of nitrogen in the moist way. He criticises the process of Wanklyn and Chapman, and proposes in its stead an oxidation in an acid solution.

The sample to be operated upon is first strongly heated with sulphuric acid ; and is thus almost invariably brought into such a state that its nitrogen is completely converted into ammonia by the following operation. The principle of the process is treatment with a sufficiency of concentrated sulphuric acid at a temperature not much below the boiling-point of the acid. The solution thus obtained is oxidised with an excess of dry powdered permanganate. Under these circumstances the organic nitrogen is completely transformed into ammonium sulphate; the liquid is then supersaturated with soda, distilled off and determined according to the usual methods.

It is essential for this process that ammonium sulphate, at the high temperature applied, and especially during the subsequent treatment with permanganate, which is attended with a very violent reaction, does not undergo decomposition. This the author has ascertained by special experiments.

The procedure may be described as follows :—The substance is weighed into a small, tared boiling flask, in which the further treatment is to take place.

Even with solids this is a very convenient arrangement, but still more so with liquids. A liquid is weighed in, the water allowed to fly off in the evaporation niche, when the extract remains where it is wanted. Oil of vitriol is then added in a sufficient excess. The quantity may vary within tolerably wide limits, though the author always employs 10 c.c. Great care must be taken that the acid does not absorb ammonia. The author has often found traces of nitrogen in the so-called pure acid of commerce, for which a small correction must be made.

The flask is then placed upon a piece of wire-gauze over a small gas-flame. As a rule the contents become black and tarry, but on continued heating a brisk reaction sets in with escape of gas, during which the substance is completely dissolved. On account of the escape of sulphurous acid and of white fumes this operation should be conducted under a draught-hood. To prevent loss by spirting the flask should be set in a slanting position until the contents are come to rest. The flask should hold about 100 c.c and have a long narrow neck. When the escape of gases has ceased the action of the sulphuric acid is not at an end ; a slow oxidation goes on ; the liquid first becoming a deep brown then light brown, yellow, and ultimately clear as water. To accelerate this process a little fuming sulphuric acid or phosphoric anhydride is added. With these additions a heating for two hours is sufficient to give a clear light brown liquid. With the albumenoids and their derivatives the formation of ammonia is as complete after heating for 1-2 hours as if the liquid had been rendered almost colourless by prolonged treatment. With other substances, such as are mentioned below, the addition of phosphoric anhydride is recommended, and heat is applied until the disappearance of the colour indicates that the action of the acid is at an end. The temperature should be a little below the boiling-point of the acid, as is indicated by occasional " bumps." At temperatures of 100°—150° the formation of ammonia is exceedingly imperfect. The substances for analysis do not require pulverisation further than is needed for obtaining a correct average portion.

The oxidation is then effected by means of permanganate, for which no efficient substitute has been found. It is applied in the state of a fine, dry powder, which is introduced in very small portions which may quickly follow each other. The oxidation is effected in the hot liquid, though the flame is removed, and is completed in less than a minute. Although the reaction is violent and is even accompanied with small flames, there is never a loss of ammonia. The completion of the process is indicated by the appearance of a green colour. The author generally allows the flask to stand over a very gentle flame for 5 to 10 minutes, without ascribing especial importance to this procedure. On no account must a strong heat be applied to the green liquid, as this would involve a serious loss of ammonia.

The liquid when sufficiently cool is diluted with water, when the green colour changes to a brown. When again cool it is introduced into the distillatory apparatus, which should hold about ¾ litre, and is connected with a top-piece sloping upwards to ensure the reflux of any spirts, and connected with a spiral condenser leading into an absorption apparatus charged with standard acid.

The soda-lye used has the spec. grav. 1·30, of which 40 c.c. are rapidly introduced into the distillatory apparatus and the stopper re-inserted. There is no perceptible loss of ammonia in this operation, and consequently no special arrangement is necessary for the introduction of the alkali.

To prevent bumping in distillation, which would render the operation simply impracticable, small zinc turnings or filings are introduced before the addition of the alkali. The slight evolution of hydrogen gas which they occasion enables the steam to be given off quite easily.

For substances containing about 1·5 per cent of nitrogen the author operates on 0·7 grm.; for richer bodies ½ grm. The results obtained by the new method agree very closely with theory and also with the figures obtained by Will and Varrentrapp's process. In connection with this process the author has obtained good results in the analysis of the alkaloids by omitting, as usually recommended, to form a channel extending along the entire combustion tube by gentle rapping. He considers that the danger of loss by the formation of nitrogenous vapours, which are not taken up by the acid, is greater than that of the dissociation of ammonia which is so often brought forward. For further security he adds a little pure sugar to the soda-lime at the front end of the tube. Whilst the soda-lime sinks together when heated and leaves an open way between itself and the sides of the tube, the sugar on combustion forms a porous carbonaceous mass which fills the entire width of the tube and through which all the gases formed by the combustion of the substance are obliged to pass.

The author, when recommending his method for organic substances in general, with a certain reserve as regards some alkaloids, admits those bodies as exceptional in which the nitrogen occurs in the form of volatile acids, such as, generally speaking, the cyanides and the oxides of nitrogen. As regards the nitrates a peculiar fact must be put on record. Whilst it might be expected that the nitric acid would be in great part volatilised by heating for hours with concentrated sulphuric acid in large excess it is found on the contrary that the greater part of the nitric acid in presence of organic matter is converted into ammonia.—*Zeitschrift Analyt. Chemie.*

DETERMINATION OF IRON BY MEANS OF PERMANGANATE IN A HYDROCHLORIC SOLUTION.

By J. KRUTWIG and ALB. COCHETEUX.

The injurious influence of hydrochloric acid in the titration of solutions containing ferrous salts by means of Margueritte's process was first pointed out in 1861 by Löwenthal and Lenssen. The importance of the method led Fresenius and others to search for means of obviating the disturbing action of hydrochloric acid. Some time ago there appeared in the *Berichte* a memoir on the same subject by Clemens Zimmermann. He recommended an addition of manganese sulphate to the hydrochloric solution. The authors have tried this method in many determinations of iron ores, and obtained accurate results so that they can recommend the use of manganese sulphate. It seemed remarkable, however, that determinations of iron which they had formerly made had likewise given figures analytically correct. They believe that the cause of this was that they dissolved the iron ore in the smallest possible quantity of hydrochloric acid (10 c.c. to 0·1 grm. of ore), adding then 400 c.c. water and about 30 c.c. sulphuric acid. Special experiments seem to justify this supposition. The use of sulphuric acid keeps down the discrepancies in the results, so that there is no objection to the use of Margueritte's process in presence of hydrochloric acid if the following precautions are observed:—

1. If possible dissolve the ore in very little sulphuric acid.
2. Reduce by means of zinc in the hydrochloric solution.
3. Add a quantity of sulphuric acid twice as great as that of the hydrochloric acid.
4. Dilute the solution to about 300 c.c.
5. Use dilute permanganate in titration.

—*Berichte Deutsch. Chem. Gesell.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING JULY 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

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To the Water Examiner, Metropolis Water Act, 1871.

London, August 7th, 1883.

Sir,—We beg to submit to you a statement of the results of our examination of the 182 samples of water collected by us during the month of July, at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during the preceding month.

Our examinations are made, as you are aware, under instructions from the Water Companies; the collection of samples, however, as well as the methods of analysis and the form of publication of the results, being left entirely to ourselves, the Companies taking no part in the matter beyond bearing the expenses.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from July 2nd to July 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination the whole without exception were clear, bright, and well filtered. In respect to aëration, and to general freedom from colour and excess of organic matter, they have maintained their excellent character; although, indeed, in one exceptional sample, the proportion of organic matter present was in excess of what is customary at this season of the year.

In our last monthly report we stated that "Of the 182 samples of water submitted to examination (including 26 samples of the Grand Junction Company's water), the whole, without exception, were clear, bright, and well filtered." We observe that your own official statement with regard to the Grand Junction Company's supply during the month of June is as follows:—"Daily samples were taken at the works, and the water found to be clear, bright, and efficiently filtered." But in Dr. Frankland's report to the Registrar-General it is stated that, "With the exception of the Grand Junction Company's water, which was very slightly turbid, all the water was efficiently filtered," this statement as to the character of the Grand Junction supply "*during* the month of June" being based on the examination of a single sample of the Company's water taken on the 19th day of the month. Since the publication of this report to the Registrar-General we have examined afresh a reserved duplicate sample of the Grand

Junction Company's water, drawn by us on the 19th day of the month, and again found it to be clear, bright, and well filtered.

Elsewhere, in the same report to the Registrar-General, it is stated that the river-derived waters supplied to London in June contained from nearly 2 to 2¾ times as much "organic impurity" as a certain well-water standard, peculiar to the reporter. As usual, it is not thought advisable to point out that measured by the same peculiar standard, the "organic impurity" of the highly-reputed Loch Katrine water supplied to Glasgow is, according to the reporter's own figures, in excess of that present in the Grand Junction, Chelsea, West Middlesex, Lambeth, and East London Companies' waters, and is double that present in the New River Company's water.

We would renew our protest against the use of this misleading scale of implied unwholesomeness, and the partizan purposes it is skilfully made to subserve,—a protest especially called for at the present time, when the possible spread of cholera from Egypt to the United Kingdom has directed unusual attention to questions of water-supply, and more particularly to the supply of the Metropolis. Now, either this supply is wholesome and suitable, as well during periods of epidemic as at other periods, or it is unwholesome and therefore unsuitable. The present sources, if unwholesome, ought clearly to be abandoned, at almost any cost. But if these sources, from which water has been supplied continuously to the largest and one of the healthiest among great cities, are determined by competent and impartial authority to be wholesome, it would seem scarcely fitting that an official reporter, whatever the earnestness of his personal convictions, should, by appealing to an arbitrary scale of his own invention, and with the object of enforcing his own individual view, subject these sources to persistent disparagement; and thereby create the unfounded alarms that were so strongly deprecated by the Royal Commission who last inquired into the water supply of London. The public ought persistently to bear in mind, and make due allowance for the fact, that the monthly reports to the Registrar-General are furnished by a chemist eminently hostile to the present riverian supply; and one whose views and startling modes of statement were alike discountenanced by the late Royal Commission, when having his reports and evidence under consideration.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

CARBON.

ALTHOUGH there is a large mass of material relating to the atomic weight of carbon, much of it may be summarily set aside as having no value for present purposes. The density of carbon dioxide, which has been scrupulously determined by many investigators,† leads to no safe estimate of the constant under consideration. The numerous analyses of hydrocarbons, like the analyses of naphthalene by Mitscherlich, Woskresensky, Fownes, and Dumas, give results scarcely more satisfactory. In short, all the work done upon the atomic weight of carbon before the year 1840 may be safely rejected as unsuited to the present requirements of exact science. As for methods of estimation we need consider but three, as follows:—

First.—The analysis of organic salts of silver.
Second.—The determination of the weight of carbon-dioxide formed by the combustion of a known weight of carbon.
Third.—The method of Stas, by the combustion of carbon monoxide.

The first of these methods, which is also the least accurate, was employed by Liebig and Redtenbacher* in 1840. They worked with the acetate, tartrate, racemate, and malate of silver, making five ignitions of each salt, and determining the percentage of metal. From one to nine grms. of material were used in each experiment.

In the acetate the following percentages of silver were found:—

64·615
64·624
64·623
64·614
64·610

Mean 64·6172 ± 0·0018

After applying corrections for weighing in air this mean becomes 64·6065.

In the tartrate the silver came out as follows:—

59·297
59·299
59·287
59·293
59·293

Mean 59·2938 ± 0·0014

Or reduced to a vacuum 59·2806.

In the racemate we have:—

59·290
59·292
59·287
59·283
59·284

Mean 59·2872 ± 0·0012

Or, corrected, 59·2769.

And from the malate:—

61·996
61·972
62·015
62·059
62·011

Mean 62.0106 ± 0·0096

Or, corrected, 62·0016.

Now, applying to these mean results the atomic weights already found for oxygen and silver, we get the following values for carbon:—

From the acetate	C = 12·0306	± 0·0047
,, tartrate	,, = 12·0356	0·0064
,, racemate	,, = 12·0413	0·0063
,, malate	,, = 12·0408	0·0054
General mean	,, = 12·0363	± 0·0028

Now these results, although remarkably concordant, are by no means unimpeachable. They involve two possible sources of constant error, namely, impurity of material and the volatility of the silver. These objections have both

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† Notably by Lavoisier, Biot and Arago, De Saussure, Dulong and Berzelius, Buff, Von Rede, Regnault, and Marchand. For details, Van Geun's monograph may be consulted

* *Ann. Chem. Pharm.*, 38, 137. *Mem. Chem. Soc.*, 1, 9. *Phil. Mag.*, (3), 19, 210.

been raised by Stas, who found that the silver tartrate, prepared as Liebig and Redtenbacher prepared it, always carried traces of the nitrate, and that he, by the ignition of that salt, could not get results at all agreeing with theirs. In the case of the acetate a similar impurity would lower the percentage of silver, and thus both sources of error would reinforce each other and make the atomic weight of carbon come out too high. With the three other salts the two sources of error act in opposite directions, although the volatility of the silver is probably far greater in its influence than the impurity. Even if we had no other data relating to the atomic weight of carbon, it would be clear from these facts that the results obtained by Liebig and Redtenbacher must be decidedly in excess of the true figure.

A different method of dealing with organic silver salts was adopted by Maumené,* in 1846, for the purpose of establishing, by reference to carbon, the atomic weight of silver. We will simply reverse his results and apply them to the atomic weight of carbon. He effected the combustion of the acetate and the oxalate of silver, and, by weighing both the residual metal and the carbon dioxide formed, he fixed the ratio between these two substances. In the case of the acetate his weighings show that for every grm. of metallic silver the weights of CO_2 were produced, which are shown in the third column:—

8·083 grm.	Ag=	6·585 grm.	CO_2.	0·8147
11·215	,,	9·135	,,	0·8136
14·351	,,	11·6935	,,	0·8148
9·030	,,	7·358	,,	0·8148
20·227	,,	16·475	,,	0·8145

Mean 0·81448

The oxalate of silver, ignited by itself, decomposes too violently to give good results; and for this reason it was not used by Liebig and Redtenbacher. Maumené, however, found that when the salt was mixed with sand the combustion could be tranquilly effected. The oxalate employed, however, with the exception of the sample represented in the last experiment of the series, contained traces of nitrate, so that these results involve slight errors. For each grm. of silver the appended weights of CO_2 were obtained:—

14·299 grm.	Ag=	5·835 grm.	CO_2.	0·4081
17·754	,,	7·217	,,	0·4059
11·550	,,	4·703	,,	0·4072
10·771	,,	4·387	,,	0·4073
8·674	,,	3·533	,,	0·4073
11·4355	,,	4·658	,,	0·4073

Mean 0·40718

Now, one of these salts being formed by a bivalent and the other by a univalent acid, we have to reduce both to a common standard. Doing this, we have the following results for the ratio between the atomic weight of silver and the molecular weight of CO_2; if Ag = 1·00.

From the acetate, CO_2 = 0·40724 ± 0·000076
,, oxalate ,, = 0·40718 0·000185

General mean ,, 0·40723 ± 0·000071

Here the slight error due to the impurity of the oxalate becomes of such trifling weight that it practically vanishes.

From these data if Ag = 107·675 ± 0·0096, CO_2 = 43·8485 ± 0·0086.

Hence C = 11·9219 ± 0·0111.

As has already been said the volatility of silver renders all the foregoing results more or less uncertain. Far better figures are furnished by the combustion of carbon directly, as carried out by Dumas and Stas† in 1840 and by Erdmann and Marchand‡ in 1841. In both investigations weighed quantities of diamond, of natural graphite, and of artificial graphite were burned in oxygen and the amount of dioxide produced was estimated by the usual methods. The graphite employed was purified with extreme care by treatment with strong nitric acid and by fusion with caustic alkali. I have reduced all the published weighings to a common standard, so as to show in the third column the amount of oxygen which combines with a unit weight (say one grm.) of carbon. Taking Dumas and Stas' results first in order we have from natural graphite:—

1·000 grm.	C gave	3·671 grm.	CO_2.	2·6710
0·998	,,	3·660	,,	2·6673
0·994	,,	3·645	,,	2·6670
1·216	,,	4·461	,,	2·6686
1·471	,,	5·395	,,	2·6676

Mean 2·6683 ± 0·0005

With artificial graphite:—

0·992 grm.	C gave	3·642 grm.	CO_2.	2·6714
0·998	,,	3·662	,,	2·6682
1·660	,,	6·085	,,	2·6654
1·465	,,	5·365	,,	2·6744

Mean 2·66985 ± 0·0013

And with diamond:—

0·708 grm.	C gave	2·598 grm.	CO_2.	2·6695
0·864	,,	3·1675		2·6661
1·219	,,	4·465		2·6628
1·232	,,	4·519		2·6680
1·375	,,	5·041		2·6662

Mean 2·6665 ± 0·0007

Erdmann and Marchand's figures for natural graphite give the following results:—

1·5376 grm.	gave	5·6367 grm.	CO_2	2·6659
1·6494	,,	6·0384	,,	2·6609
1·4505	,,	5·31575	,,	2·6647

In one experiment 1·8935 grm. of artificial graphite gave 6·9355 grm. CO_2. Ratio for O, 2·6628. This, combined with the foregoing series, gives a mean of 2·6636 ± 0·0007.

With diamond they found:—

0·8052 grm.	gave	2·9467 grm.	CO_2.	2·6596
1·0858	,,	3·9875	,,	2·6632
1·3557	,,	4·9659	,,	2·6629
1·6305	,,	5·97945	,,	2·6673
0·7500	,,	2·7490	,,	2·6653

Mean 2·6637 ± 0·0009

Now, combining all these series, we get the following result:—

Dumas and Stas, 1st set ..	2·6683 ±	0·0005
2nd ,, ..	2·66985	0·0013
3rd ,, ..	2·6665	0·0007
Erdmann and Marchand, 1st ..	2·6636	0·0007
2nd ..	2·6637	0·0009
General mean	2·66655 ±	0·0003

Hence, if O = 15·9633 ± 0·0035, C = 11·973 ± 0·0030.

Another very exact method for determining the atomic weight of carbon was employed by Stas* in 1849. Carefully purified carbon monoxide was passed over a known weight of copper oxide at a red heat, and both the residual metal and the carbon dioxide formed were weighed. The weighings were reduced to a vacuum standard, and in each experiment a quantity of copper oxide was taken representing from eight to twenty-four grammes of oxygen. The method, as will at once be seen, is in all essential features similar to that usually employed for determining

* *Ann. de Chim. et de Phys.* (3), 18, 41.
† *Comptes Rendus*, 11, 991-1008. *Ann. Chim. Phys.* (3), 1, 1.
‡ *Journ. f. Prakt. Chem.*, 23, 150.

* *Bull. Acad. Bruxelles*, 1849 (1), 31.

the composition of water. The figures in the third column, deduced from the weights given by Stas, represent the quantity of carbon monoxide corresponding to one gramme of oxygen:—

9·265	grms. O =	25·483	CO_2	1·75046
8·327	,,	22·900	,,	1·75010
13·9438	,,	38·351	,,	1·75040
11·6124	,,	31·935	,,	1·75008
18·763	,,	51·6055	,,	1·75039
19·581	,,	53·8465	,,	1·74994
22·515	,,	61·926	,,	1·75043
24·360	,,	67·003	,,	1·75053
			Mean	1·75029 ± 0·00005

Hence the molecular weight of carbon monoxide is 27·9404 ± 0·0062. And C = 11·9771 ± 0·0071.

Now, in order to complete our discussion, we must combine the four values we have found for carbon:—

1. By Liebig and Redtenbacher ..	C =	12·0363 ±	0·0028
2. By Maumené's figures .. .. ,,		11·9219	0·0111
3. By combustion of carbon.. .. ,,		11·9730	0·0030
4. By Stas's method .. .. .. ,,		11·9771	0·0071
General mean .. .. ,,		12·0021 ±	0·0019

But values one and two are hardly reliable enough to be included in our final estimate. They involve dangerous constant errors, and ought, therefore, to be disregarded. Rejecting them altogether, and taking a general mean from values three and four, we get for the most probable figure for the atomic weight of carbon, C = 11·9736 ± 0·0028. If oxygen is 16, then carbon becomes 12·0011. In other words, the ratio between oxygen and carbon is almost exactly 16 to 12.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 1.

Formation of Dibrom-dinitro-methan and of the Tetra-nitro-ethylen-bromide of Villiers. — S. M. Losanitsch.—These two compounds are identical.

Sequel to a Communication on the Action of Concentrated Sulphuric Acid upon Dinitro-anthraquinone.—C. Liebermann.—This memoir does not admit of useful abstraction.

History of the Cuprea-Barks.—O. Hesse.—A pharmacological paper.

Occurrence of Large Crystals of Magnesium-ammonium Phosphate in Human Urine.—H. Weiske.—In a specimen of very acid urine which had been kept for four months, and had deposited a sediment of ammonium urate, well-developed crystals of the magnesium-ammonium phosphate were found.

Action of Chloro-cyanogen on the Potassium Compound of Pyrrol.—G. L. Ciamician and M. Dennstedt.—The result of the reaction is tetrol-cyanuramid, C_4H_4N-CN.

Action of Red Fuming Nitric Acid upon Acet-acetic Ether and Mono-chlor-acet-acetic Ether.—Max Pröpper.—The author considers that the bodies which he obtained by this reaction are not nitroso-, but oximido-compounds.

A New Class of Colouring-Matters.—E. Besthorn and O. Fischer.—The authors have previously made known that certain acetyl-compounds of aromatic bases if exposed to the action of dehydrating agents at high temperatures, form a group of new colouring-matters, of which flavoline, $C_{16}H_{13}N$, serves as the type. In the present paper the author describes some of its derivatives, such as flavaniline (mono-amido-flavoline), mono-nitro-flavoline, flavenol, &c. The last-mentioned compound is obtained by dissolving flavoline in an excess of hydrochloric acid, diluting largely with water, treating with sodium nitrite, and, after boiling, mixing with concentrated hydrochloric acid. Amongst the oxidation-products of flavenol is described picolin-tricarbonic acid.

Vol. 16, No. 2.

Certain Aromatic Amines. — Ernst Louis. — The author has studied amido-propyl-benzol, its sulphate, oxalate, and acetyl-compound, benzoyl-amido-propyl-benzol, a bi-propylised aniline, propyl-phenol, its iodide; amido-iso-propyl-benzol, its sulphate and oxalate benzoyl compound, a secondary iso-propyl base, iodo-iso-propyl-benzol, and he finally examines the iso-butylation of aniline.

Activation of Oxygen by Nascent Hydrogen.—F. Hoppe-Seyler.—The author maintains, in opposition to H. Traube, that nascent hydrogen in presence of oxygen gas occasions energetic oxidation.

Fermentation of Cellulose.—F. Hoppe-Seyler.—The author proves that cellulose in sewage deposits is decomposed by ferments into a mixture of carbonic acid and methane. A small percentage of free hydrogen is also present, whence it follows that organic compounds have been formed containing a lower proportion of oxygen and hydrogen than occurs in cellulose.

Activation of Oxygen.—M. Traube.—The author discusses at length the oxidation of carbon monoxide by palladium hydride and oxygen, and the activation of oxygen by palladium. He considers the following bodies only as capable of activating oxygen:—The precious metals, especially those of the platinum group, copper oxide in certain solutions, the alkalies (in comparatively rare cases), and phosphorus. All these bodies, except phosphorus, are indifferent towards oxygen at common temperatures, even in presence of water. Phosphorus is certainly autoxidable, but, like palladium-hydride, it does not activate oxygen by its autoxidation. Phosphorus is the only autoxidisable body which yields ozone.

Transformation of Acetacetester into Succinylo-succinic Ester or respectively Hydroquinone.—C. Duisberg.—Not suitable for abstraction.

Combustion of Sulphur with a White Phosphorescent Flame.—K. Heumann.—The author raises the question whether sulphur, selenium, arsenic, &c., are not, under suitable circumstances, capable of phosphorescing like phosphorus. He finds that when sulphur is heated on a metal or porcelain plate in the dark, the vapours suddenly become phosphorescent, burn with a bluish grey flame, perfectly distinct from the ordinary fine blue flame of sulphur. The odour given off is not that of sulphurous acid, but resembles that of hydrogen persulphide, camphor, and ozone. The product of the combustion is doubtless a stage of oxidation lower than sulphurous anhydride.

Certain Isothiamides and the Amidines obtained from them.—O. Wallach and M. Wüsten.—Proceeding from thio-formanilide the authors obtain ethyl-iso-thio-formanilide.

Use of Potassium Bisulphate as a Condensation-Agent. — O. Wallach and M. Wüsten.—The authors point out the disadvantages of sulphuric acid and of zinc chloride, the agents most in use, and recommend potassium bisulphate, which they have used with success in a number of cases, some of which are here described.

Specific-heat and Valence of Thorium.—L. F. Nilson.—The author concludes from his experiments that

if the law of Dulong and Petit is to apply to the specific-heat of thorium as determined, the quadrivalence of the metal follows of course, since its atomic-heat ($Th'''' = 232{\cdot}4$) is then perfectly normal $= 6{\cdot}4$. It may therefore be regarded as finally proved that thorium must rank among the quadrivalent elements, its only known oxide being regarded as ThO_2. Prof. Nilson gives the following summary of its agreement with quadrivalent elements:—

1. Atomic heat for $Th'''' = 6{\cdot}4$.
2. Atomic volume $= 20{\cdot}94$, in accord with zirconium, cerium, lanthanum, and didymium.
3. Crystalline form of thorium; isomorphous with silicium.
4. Crystalline form of thorium oxide; isomorphous with stannic oxide, zirconia, titanium oxide.
5. Crystalline form of thorite; isomorphous with zircon.
6. Molecular volume of thorium oxide; accordance with CeO_2, UrO_2.
7. Molecular heat of thorium oxide; accordance with ZrO_2, $ZrSiO_4$, CeO_2, SnO_2, MnO_2.
8. Atomic heat of the oxygen in thorium oxide; accordance with the same compounds.
9. Composition of thorium double fluorides.
10. Composition of the platinum chloride; accordance with tin and zirconium.
11. Thorium forms with platinum a very fusible alloy; accordance with silicium.

Synthesis of Cinnamic Acid according to T. Swarts.—E. Erlenmeyer.—The acid which Swarts took for cinnamic acid, seems to have been phenyl-propiolic acid.

Ortho-nitro-cinnamyl-acetacetic Ether.—E. Fischer and H. Kuzel.—An account of acetonyl-quinoline, of the reduction of ortho-nitro-cinnamyl-acetacetic ether, and of cinnamyl-acetacetic ether.

Isonitroso-Compounds.—V. Meyer.—A discussion of the constitution of acetoxim.

Acetoxims.—Alois Janny.—The author has studied the splitting up of acetoxim by the action of acids; its behaviour with acetic anhydride, acetyl chloride, benzoyl chloride, and phosphorus pentoxide. He describes, further, acetoxim hydrochlorate, the sodium derivative of acetoxim, the benzyl compound, and benzyl-hydroxyl-amine.

Isonitroso-ketones.—C. Schramm.—An account of isonitroso-methyl-acetone and of ethyl-methyl-acetoximic acid.

Acetoximic Acids.—C. Schramm.—The author has obtained two further homologues of the acetoximic acid, described by V. Meyer and A. Janny.

Oxygen Acids of Chlorine.—C. W. Blomstrand.—A reply to W. Spring, who asserts that in the acids of chlorine the chlorine atoms possess identical functions and properties.

Sulphaminic and Oxy-acids derived from Pseudo-cumol.—Oscar Jacobsen and H. Meyer.—The authors describe sulphamin-xylylic acid, sulphamin-xylidinic acid, oxy-xylidinic acid, and oxy-trimellitic acid.

Amido-meta-xylol-sulphonic Acid, 1, 3, 4, 6.—Oscar Jacobsen and H. Ledderboge.—In order to separate the bases present in commercial xylidine in the form of sulphonic acids the authors have treated xylidine from two different sources with sulphuric acid. They obtained essentially only a single amido-xylol-sulphonic acid, which appears derived from 1, 3, 4 meta-xylidine. A second acid distinguished by its less soluble and more readily crystalline barium salt was not found at all in the one case, and was present in the other in too small quantities to admit of nearer examination.

Para-xanthine, a New Constituent of Normal Human Urine.—G. Salomon.—Para-xanthine has the composition $C_{15}H_{17}N_9O_4$; it forms colourless crystals of a vitreous lustre, containing no crystalline water. It is insoluble in alcohol and ether, and dissolves much more readily in hot than in cold water. It is evidently closely allied to guanine, xanthine, and hypo-xanthine.

Determination of Sulphurous Acid in Wine.—V. Wartha.—The author maintains the accuracy of his method, which consists in adding solution of silver nitrate to the distillate of the wine, and inferring the presence of sulphurous acid from a white precipitate, soluble in nitric acid.

Action of Quinoline upon Chloroform and Iodoform.—O. Rhoussopoulos.—With chloroform the reaction takes place at temperatures above 300°, but with iodoform at ordinary temperatures. In the latter case the product is methan-trichinoil-hydriodate.

Glycocolls, Glycocollic Ethers, and Oxethylen-ureas of the Toluyl and Xylyl Series.—A. Ehrlich.—We find here an account of ortho-toluyl-glycocoll-toluidide and of xylyl-glycocoll.

Aldehyd-ammonium Bases.—G. Meyer.—The author's object in these researches is to determine the constitution of muscarine.

Action of Trimethylen-bromide upon Sodium Acetacetic Ether.—W. H. Perkin, jr.—The author obtains a compound of the composition $C_9H_{14}O_3$, having the vapour-density 6·21, and a corresponding acid, $C_7H_9O_3$.

The Condensation-Products of Œnanthol.—W. H. Perkin, jr.—The author has studied the oxidation of the aldehyd $C_{14}H_{26}O$, and the action of potassium hydrate upon $C_{14}H_{26}O$.

Cosmos les Mondes.
Tome v., No. 13, July 28, 1883.

A New Substance Sensitive to Light.—Dr. D. Tommasi.—Anthracene, after exposure to light, acquires different physical and chemical properties without any change in its composition. If a cold, clear, saturated solution of anthracene in benzol is exposed to the direct rays of the sun, it becomes turbid and deposits crystals. This photogenic substance is a polymer of anthracene, and has received the name paranthracene. If melted, it is suddenly re-converted into anthracene.

Prof. Fittig is said to have obtained a sulphur acid as a very stable powder, insoluble in water.

[Dr. Tommasi credits these paragraphs to the *Photographic News* and the *Revue Scientifique*.]

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xii., Part 7.

Self-Purification of Streams contaminated by Drainage from Peat-Bogs.—Prof. W. N. Hartley.—An abstract of a paper read before the Society of Arts.

The Kehdinger Moor and its Amelioration by Means of Marsh-Soil.—Dr. C. Virchow.—The principal point in this memoir is the notice of a stratum of sub-soil known locally as "mai-bolt," or poison-earth, from its destructive action upon vegetation. It contains abundance of vivianite, iron-ochre, and iron sulphide, and retains its injurious properties, even after exposure to the air for eight to nine years.

Experiments on the Action of Sulphuric Acid as Manure.—Prof. F. Farsky.—A clayey soil was treated with sulphuric acid in the proportion of 100 grms. to 3500 grms. of mould. Another portion received a corresponding dose of the solution of sodium bisulphate. Both were without action upon moist soils, and reduced the yield of a dry soil.

So-called Reversion of Phosphoric Acid in Superphosphates.—Prof. J. Post.—Reversion consists not merely in the precipitation of iron and aluminium phosphates which were originally soluble, but a further part of the phosphoric acid which was soluble at first enters

into reaction with insoluble portions of the superphosphate. A part of the free phosphoric acid enters into combination with iron and aluminium and calcium phosphate is also deposited, probably as double iron and aluminium calcium phosphate.

MISCELLANEOUS.

Cinchona Ledgeriana.—Under this name a species of cinchona has of late years attracted a considerable amount of attention in consequence of its high value in its yield of quinine. In the year 1865 a native servant of Mr. C. Ledger, collected the seed from fifty trees growing, according to the Kew report for 1880, "in the almost inaccessible banks of the River Mamore, in Bolivia, a place to which no botanist has ever approached more nearly than one hundred miles. It was sent to London to the care of Mr. Ledger's brother, who sold half to the Dutch Government for Java, and half to Mr. Money, a cinchona planter on the Nilgiri Hills." "The seed purchased by the Netherlands Government was," continues the Kew Report, quoting from a report made by Dr. Siemens to the Colonial Secretary in Ceylon, "sent to Java, and 20,000 plants were raised from it, a number afterwards reduced to some 6300." This purchase," we read further on, "proved a very fortunate one for the Dutch, and may be said to have infused new life into the flagging cinchona cultivation of Java. Up to the year 1872 the bark sent thence had been almost wholly of inferior quality, but in 1873 it was found that of the new kind afforded eight per cent of alkaloids, of which from 5½ to 6½ was genuine. In 1874 this was greatly exceeded, one sample even reaching a total of 12·97 alkaloids, 11·01 being quinine." To this is appended a note to the effect that Dr. King, of Calcutta, has stated that some of the plants in the Dutch plantations "have yielded on analysis the extraordinary amount of 13·7 per cent of quinine." It is not to be wondered at that a plant so extremely rich in this valuable alkaloid should attract the attention it did at a recent meeting of the Linnean Society, when Mr. J. E. Howard, F.R.S., the best living authority on the subject of cinchonas, read a paper on the subject. The question between botanists is whether the plant now generally known as *Cinchona Ledgeriana* is really entitled to rank as a distinct species. Mr. Howard looks upon it as a variety of *C. Calisaya*, white other botanists consider there are characters about it sufficiently strong to let it stand alone as *C. Ledgeriana*. This no doubt is an interesting point for scientists, but those who look to the practical side of the question will consider how best to increase the cultivation in the highest degree of a plant that yields, on the authority of Mr. Howard himself, so high a percentage of quinine as from 7 to 12 on an average. The difficulty hitherto has been to obtain seeds of this valuable plant, and consequently while the demand for it has been great the supply has been extremely limited. Indeed planters have been unable in many cases to obtain the seeds at all. It is satisfactory, therefore, to know that by the energy of Mr. T. Christy, of 155, Fenchurch-street, he has succeeded in obtaining seeds and raising plants in sufficient quantity to supply those interested in the culture. The genuineness of Mr. Christy's plants which he exhibited at the Linnean Society's meeting was verified by Mr. Howard.—*Land and Water*, Aug. 11th.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Corrosion of Boilers.—(Reply to "An Old Subscriber.")—The information will be supplied shortly it is hoped.—G.A.K.

ERRATUM.—Page 85, col. 2, line 32 from top, *for* "low" *read* "high,"

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1241.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XII.

Communicated by J. W. MALLET, Professor of General and Applied Chemistry in the University.

(Concluded from p. 98.)

(100.) *Analysis of Topaz from a New Locality in Maine, U.S.* By C. M. BRADBURY, of Petersburg, Virginia.

The material for this analysis consisted of large, colourless, topaz crystals, from Stoneham, Maine, sent by Mr. G. F. Kunz, connected with the firm of Tiffany and Co., jewellers, of New York. The occurrence of the mineral, in part in very large crystals, at this locality, was discovered by Mr. Kunz. He reported that in most of his specimens there were numerous cavities, microscopic and large, containing water and liquefied carbon dioxide.

The mineral was transparent to translucent, much fractured in the interior, showing on the outside portions of the principal crystal faces. Specific gravity, taken with one of the largest and most solid pieces, = 3·54.

In the analysis an attempt was made to determine the fluorine by Penfield's method,* but neither by heating with strong sulphuric acid nor with potassium acid sulphate could anything like complete decomposition be effected. Recourse was therefore had to the older method of Berzelius. The mineral was crushed in a steel diamond mortar, avoiding altogether the use of an agate mortar. The powder was washed free of iron by treatment with cold, very dilute hydrochloric acid, and the finest portion separated by elutriation. This finest portion only was then dried, weighed, fused with sodium carbonate, and the fused mass disintegrated by water. The insoluble portion was caught on a filter and well washed, the filtrate and washings digested with ammonium carbonate, the precipitate—of silicic acid and aluminum hydrate and silicate—filtered off, washed, and the last portions of silicic acid separated from the filtrate by evaporation with an ammoniacal solution of zinc, filtering off the zinc silicate. This last was decomposed by evaporation to dryness with nitric acid, the re-dissolved zinc thrown away, and the residue of silica added to that obtained in the usual way from the original residue insoluble in water and from the precipitate formed by ammonium carbonate. The aluminum was determined in the filtrates from silica. The original aqueous solution, having been thus cleared of silicon and aluminum, was treated with calcium chloride, the mixed precipitate of calcium fluoride and carbonate was washed, dried, and ignited, treated with a slight excess of acetic acid, evaporated to dryness on a water-bath, the calcium acetate washed out with water, and the residual fluoride well washed, dried, ignited, and weighed. It was found, in this and two other similar analyses of topaz, that in the calcium fluoride so obtained there was retained a minute amount of alumina, which was separated and determined.

The results were as follows:—

Al	27·14
Si	14·64
F	29·21
O	28·56
	99·55

The oxygen being taken as the sum of that in the Al_2O_3 and SiO_2 found, minus the equivalent of the fluorine (one atom of O for two of F).

These results agree very fairly with the well-established formula for topaz—

$$Al_2SiO_5,$$

with fluorine replacing a part of the oxygen, except that the proportion of fluorine is much larger than usual: instead of its taking the place of *one-half* the oxygen corresponding to silicon, it represents pretty accurately *three-fourths* of this.

This remarkable anomaly leads to a question of the correctness of the analysis; and although Mr. Bradbury knew of no ground for suspecting inaccuracy in any part of his work (which was very carefully done), and the summation of the percentage results is satisfactory, it seemed very desirable to secure a repetition of the analysis. The near approach of the close of the working session prevented this. On the whole, it is perhaps well to publish the results obtained, as they may represent an unusual variety of the mineral, though such a conclusion must be looked upon as requiring confirmation.

(101.) *On a Variety of Chrysocolla from Arizona.* By W. C. EUSTIS, of Washington, D.C.

This formed a part of a mass from the Ivanhoe Mine, in Arizona, 80 miles west of Silver City. Most of the specimen consisted of carbonate, but associated with this were two sensibly different varieties of chrysocolla, the one bluish green, more or less translucent, and yielding much less water than the other, which was of a pure emerald-green colour, transparent, with vitreous lustre, and in imperfectly crystalline grains, doubtless pseudomorphous. This last substance was that submitted to analysis. Its specific gravity was 2·3. Hardness = 3·5.

The composition was found to be:—

CuO	33·22
SiO_2	34·08
H_2O	31·65
	98 95

No traces of other substances could be found, and as the cupric oxide and silica were very accurately determined, the water might perhaps even better be taken by difference than from the direct determination, though this would scarcely change the result.

These figures correspond to the empirical formula,—

$$(CuO)_3(SiO_2)_4(H_2O)_{13},$$

or to—

$$(\tfrac{3}{4}Cu+\tfrac{1}{4}H_2).SiO_3.3H_2O,$$

in which we have a partially acid or hydrogen silicate.

The relation to other allied minerals is shown in the following series:—

Dioptase	$CuSiO_3.H_2O$
Chrysocolla; ordinary	$CuSiO_3.2H_2O$
Ditto; some specimens	$CuSiO_3.3H_2O$
Ditto; mineral now described ..	$(\tfrac{3}{4}Cu+\tfrac{1}{4}H_2)SiO_3.3H_2O$

(102.) *Determination of the Alkaline Metals in a Lepidote from India.* By M. PAGE, of the University of Virginia.

The lepidolite in question came from Pihra-Hazáribágh —Chutia Nagpur—Bengal, and was sent me by my brother, Mr. F. R. Mallet, of the Geological Survey of India, who has described* the conditions under which the mineral occurs. It is found in granite, in irregular

* *Amer. Chem. Jour.*, April, 1879, p. 27.

* "Records of the Geological Survey of India," vii., pt. I., p. 43

masses, and of two varieties, the one a violet-red in colour, the other a lead-grey, both associated with quartz, and occasionally enclosing small black grains and crystals of tinstone.

An analysis, by Mr. Tween, of the violet-red variety is reported* as follows:—

Silica	50·39
Alumina	31·63
Oxide of manganese	trace
Lithia	3·71
Potash	1·40
Soda	5·80
Fluorine	5·00
Loss on ignition	4·23
	102·16

The loss on ignition clearly ought not to be added to the sum of the ingredients found unless they were determined from the ignited residue, since the loss at any rate includes silicon fluoride. These results differ widely from those of all previous analyses of lepidolite as regards the proportions in which the alkaline metals occur, much more sodium and less potassium than usual being present, while no reference is made to the presence or absence of the rarer metals, cæsium, rubidium, and thallium.

Mr. Page undertook to examine the alkaline ingredients of my specimen, which, however, represented the dark lead-grey variety, without any tint of violet. A large quantity (102 grms.) of the mineral was used, and was decomposed by fusion with a mixture of ammonium chloride and a natural calcium carbonate, the minute amount of alkali (potassium and sodium) in which had been previously very accurately determined. The mixed alkaline chlorides, freed from all other substances, were digested for a long time in alcohol of 90 per cent, the insoluble residue separated and washed with alcohol of the same strength until no lithium could be detected in the washings by means of the spectroscope. The residue was then dissolved in water, the solution freed from alcohol by heat, a definite fraction of the whole evaporated to dryness, and the sum of the alkaline chlorides present ascertained, this re-dissolved, potassium and rubidium thrown down by platinum chloride, freed from sodium by treatment with 86 per cent alcohol, and the sum of the two double salts determined, the sodium being obtained by difference. The rest of this main watery solution was then used to determine rubidium alone by fractional precipitation with platinum chloride, and washing with boiling water as often as twenty times, *i.e.*, several times after but mere traces of potassium could be detected in the washings with the aid of the spectroscope. In the original alcoholic solution a little potassium was determined in one fraction as platino-chloride, the lithium in another fraction as phosphate, and a minute amount of sodium by difference, the sum of all the chlorides having been got by evaporation.

Subtracting the known and extremely small quantities of alkaline metals derived from the limestone used, calculating those of the lepidolite as monoxides (the form most commonly reported), and stating the results as for 100 parts of the mineral examined, there were obtained—

K_2O	8·595 p.c.
Li_2O	1·754 ,,
Na_2O	0·609 ,,
Rb_2O	0·070 ,,

A doubtful trace of cæsium was recorded as the result of spectroscopic observation, but no thallium was found.

(103.) *Analysis of the so-called "Tobacco Stems" rejected in the Manufacture of Tobacco in Virginia.* By C. G. MEMMINGER, of Charleston, South Carolina.

This material consists of the midribs of tobacco leaves, from which the membranous portions of the leaves have been stripped. The rejected midribs are in part ground up and used as inferior material in the production of some forms of manufactured tobacco, but much remains as waste, and enquiries have repeatedly been made here within the last few years as to the value to be attributed to such waste if applied as manure to land, or if mixed with other matters in forming manure composts. To answer such questions, the following analysis was made by Mr. Memminger of a fair average sample of commercial "stems," produced in the manufacture of "plug tobacco," and obtained from the firm of S. W. Venable and Co., of Petersburg, Virginia:—

Water lost at 100° C.	17·52
Total ash (exeluding CO_2), sum of constituents	16·47
CO_2 (by calculation from excess of basic over other acid constituents)	6·87
(Ditto, directly determined, 6·73)	
Organic matter (by difference)	59·14
	100·00
In the Organic Matter—	
Nicotine (determined by Kissling's method)	1·30
Nitrogen in 1·30 per cent nicotine	0·22
,, ,, nitrates (by mercury process)	0·45
,, albumenoid (by difference)	1·51
Total nitrogen (by Ruffle's method of combustion*)	2·18

Composition of the Ash.

	Including SiO_2, Al_2O_3, Fe_2O_3, and Mn_3O_4.	Excluding SiO_2, Al_2O_3, Fe_2O_3, and Mn_3O_4.
K_2O	42·95	46·25
Na_2O	6·53	7·03
CaO	24·56	26·47
MgO	6·20	6·68
Al_2O_3	0·04	—
Fe_2O_3	0·84	—
Mn_3O_4	0·09	—
SiO_2	6·18	—
P_2O_5	4·80	5·17
SO_3	3·10	3·30
Cl	6·04	6·56
Deduct O equiv. to Cl	−1·33	−1·46
	100·00	100·00

University of Virginia,
July 27, 1883.

A METHOD FOR THE QUANTITATIVE SEPARATION OF POTASSA AND SODA FROM FERRIC OXIDE, ALUMINA, LIME, AND MAGNESIA IN SILICATES.

By W. KNOP.

IF in dissolving a siliceous mineral we employ a mixture of one-third fuming hydrochloric acid and two-thirds hydrofluoric acid, everything dissolves during evaporation to a clear liquid, but on further concentration hydrochloric acid escapes, and the alkaline silico-fluorides reappear along with the chlorides of iron, aluminium, calcium, and magnesium.

If a silicate contains a quantity of silica equal to its proportion of alkaline metals, or if, supposing the silica to be insufficient or totally wanting, we dissolve the substance in 10 to 20 c.c. of water, and a few c.c. of hydrochloric acid and add a corresponding quantity of silica, we can convert its alkali metals completely into silico-fluo-

* *Loc. cit.*

* *Jour. Chem. Soc.*, xxxix., p. 87. CHEMICAL NEWS, vol. xlvii., p. 75.

rides, by adding the requisite quantity of fuming hydrofluoric acid and evaporating.

The alkaline silico-fluorides are absolutely insoluble in a mixture of ether and absolute alcohol strongly acidified with hydrochloric acid. Hence the alkaline silico-fluorides may be precipitated from a hydrochloric solution in the form of a crystalline deposit by the addition of ether and absolute alcohol. But if the hydrochloric solution contains also chlorides of iron, aluminium, calcium, and magnesium, the alkaline silico-fluorides are deposited, not in a pure state, but in combination with small quantities of the above-mentioned metals, the bulk of which, however, remain in solution as chlorides.

The process is carried out as follows:—The weighed substance is mixed in a platinum crucible with a few c.c. of water, and in case of need with a corresponding quantity of silica. A sufficiency of hydrofluoric acid is then added and all the liquid is evaporated away. The dry residue is covered with 2 to 3 c.c. of fuming hydrochloric acid, upon which it is readily detached from the crucible. It is washed into a beaker by means of an alcohol washing-bottle, using 25 or at most 50 c.c. of absolute alcohol for washing out the crucible; the acid liquid is allowed to act for some time upon the precipitate. 100 c.c. of ether are then added, and the whole is allowed to stand for 12 hours.

The ethereal liquid is poured off from the precipitate, and the alkaline silico-fluorides are brought upon a filter by means of an alcohol washing-bottle. The use of a feather is admissible only at the beginning; a glass rod is objectionable because it makes the precipitate adhere again to the inside of the glass. The precipitate may be transferred easily if the beaker is held in a sloping position over the filter, and a few c.c. of alcohol are ejected behind the precipitate so as to wash it into the filter.

The filter is then washed slightly with alcohol, so as to remove the ether; it is then dried, the precipitate removed, the paper is burnt completely in a platinum capsule; the precipitate is added to the ash, mixed with concentrated sulphuric acid, allowed to stand for some time until the silico-fluoric gas has chiefly escaped, and then ignited so long and at so low a temperature that the alkalies may remain behind as acid sulphates and be unable to react upon the silica liberated.

The residue in the capsule is drenched with 10 to 20 c.c. of ammonia and evaporated to dryness, or at least to a paste-like condition. The mass takes again an acid condition by the loss of ammonia, and strong ammonia is therefore added drop by drop until the reaction is again alkaline. The mixture is then allowed to stand for an hour to allow of the complete separation of the ferric oxide and the alumina. Upon the pasty mass is then poured about 20 c.c. of a solution of ammonium monocarbonate (prepared by mixing 180 c.c. ammonia sp. gr. 0·92 with 230 grms. ammonium sesquicarbonate and water enough to make up one litre), and allowed to stand for 12 hours in the covered platinum capsule.

The quantities of ferric oxide, alumina, lime, and magnesia thus separated are so small that the entire precipitate may be collected upon a very small filter. It is washed with the smallest possible quantity of the above-mentioned ammonium carbonate.

The filtrate is now exposed first for some time to a very gentle heat, a quantity of ammonium bitartrate corresponding to the ammonium sulphate present in the solution is added, the liquid is evaporated to dryness, and the residue is heated for some time in the air-bath to a temperature above 100°. The object of adding ammonium bitartrate is to prevent spirting during the ignition of the ammonium sulphate. The residue is ignited till perfectly white, and weighed. It is then re-dissolved in hot water, mixed with 2 to 3 drops of the solution of ammonium mono-carbonate and set aside to see if any further deposit of iron oxide and alumina takes place.

If this is the case the liquid is again evaporated to dryness. These supplemental deposits generally attach themselves so firmly to the platinum that a clear solution is obtained on drenching the residue with 10 to 20 c.c. of boiling water. This solution is decanted into a second platinum capsule in which the solution is evaporated to dryness and the capsule is again strongly ignited and weighed. It is recommended to add a few drops of sulphuric acid during this second evaporation.—*Zeitschrift für Analyt. Chemie.*

ON THE

VOLUMETRIC DETERMINATION OF COPPER BY MEANS OF POTASSIC CYANIDE.—PARKES'S PROCESS.*

By J. J. and C. BERINGER.

THE process is based upon the facts (1) that when ammonia is added in excess to a solution containing copper, ammoniacal copper compounds are produced which give to the solution a deep blue colour; and (2) that when potassic cyanide is added in sufficient quantity to such an ammoniacal solution the colour is removed, double cyanides of copper and potassium and ammonium being formed.

Except under certain conditions hereinafter stated, reliance on the accuracy of the process cannot rest upon the supposition that the cyanide required for decolouration is proportional to the copper present; for that this in the ordinary way of working is incorrect is well known. A decomposition of the cyanide goes on, of which urea, oxalate of urea, and formate of ammonia are some of the products.

"The decomposition is not always the same, the quantity and degree of concentration of the ammonia has a marked influence on it," and "neutral ammonia salts also affect the result."† Referring to this effect of ammonic salts, Crookes, in his description of Steinbeck's modification of the process, states that when "larger quantities of ammoniacal salts are present, . . . and especially when carbonate, sulphate, and, worse still, chloride of ammonium, are simultaneously present, these salts exert a very disturbing influence."‡

Notwithstanding this objection the method is largely used, and yields fairly accurate results when "the standardising of the cyanide of potassium and the actual analysis are performed under very similar circumstances." "The results are not only concordant, but also very nearly correct, if the cyanide is standardised under the same conditions as it is used. In standardising, about the same quantity of copper should be employed as will have to be estimated."‖

In our opinion, for accurate work it is best to have the assay solution, and that used for standardising, the same as nearly as possible, even to containing about the same amount of ferric hydrate; and to titrate the two solutions side by side.

It occurred to us that the interference of ammonic salts is due to a reaction with potassic cyanide, by which ammonic cyanide is formed; and that the excess of cyanide is required either because ammonic cyanide decomposes more rapidly, or because it is less active than the corresponding potassium salt. In this case the use of soda or potash for neutralising the excess of acid used for dissolving the ore would eliminate the disturbing element. It seemed to us, too, advisable to determine whether the conditions of the assay might be so arranged as to yield proportional results. With a view of solving these

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* From the "Reports and Proceedings of the Miners' Association of Cornwall and Devon."

† Fresenius "Quantitative Analysis," vol. i., page 259

‡ "Select Methods in Chemical Analysis," p. 193.

‖ Fresenius.

problems we tried a large number of experiments, in which we used—

Standard "Copper Sulphate."—15·753 grms. of recrystallised copper sulphate, dissolved and diluted to 1 litre.

*Standard "Potassic Cyanide."**—35 grms. of potassic cyanide, dissolved and diluted to 1 litre.

"Ammonia."—One volume of Liq. Ammoniæ, sp. gr. 88°, diluted to 5 volumes.

"Soda."—A 10 per cent solution of caustic soda.

Effect of Variations in the Manner of Working.

In the experiments, except it is otherwise stated, the bulk of solution at the end of the assay was about 325 c.c.† The "cyanide" was run in rather quickly until the colour became very perceptibly fainter (*i.e.*, to within 1·0 or 1·5 c.c. from the end). It was then run in deliberately, but without protracted delay, five or six drops at a time, then two, then one, until the faintest possible tint of violet remained. A titration thus performed occupies from three to four minutes.

There is no doubt that different modes of working will yield different finishing points. In five experiments, in which the time occupied in titration varied from five minutes to half an hour, the quantities of "cyanide" required were 24·8 c.c., 24·5 c.c., 24·2 c.c., and 24·6 c.c. respectively. Another, titrated in the manner described above, required 24·8 c.c. The quantity used seemed to depend less upon the actual time occupied in the assay than upon the speed with which the last 2 or 3 c.c. were run in. In each experiment "copper sulphate" 50 c.c., "ammonia" 75 c.c., and "soda" 4 c.c. were used. These experiments indicate that everything depends upon the mode of finishing. The following experiments show that the excess of cyanide acts very slowly; we made a series of five solutions, similar to the last:—

1. Titrated in the ordinary way, required 24·8 c.c. of "cyanide."
2. Added 24·6 c.c. of "cyanide." After standing five minutes this had still a blue tint, but was almost finished.
3. Added 24·4 c.c. of "cyanide." Blue tint, nearly done, after standing seven minutes."
4. Added 24·2 c.c. of "cyanide." After five minutes was distinctly blue; after 15 minutes was still blue, but nearly done.
5. Added 24·0 c.c. of "cyanide." Was very distinctly blue after standing half an hour; after an hour and a half was paler, but distinctly blue.

Another series of experiments was made to determine whether or not delay, when an insufficient amount of cyanide had been added, had any marked result. Three solutions like those used above were made, and to 1 was added 20 c.c. of cyanide solution; to 2, 18 c.c.; and to 3, 12 c.c. After standing in stoppered bottles for forty hours each was distinctly blue, and the titration being then completed in the usual manner. 1 required 4·8 c.c.; 2, 6·8 c.c.; and 3, 12·8 c.c. of standard cyanide; making the total "cyanide" required in each case 24·8 c.c. A new solution titrated at the same time required 24·9 c.c.

We think that, taken together, the experiments show that everything depends upon the manner of finishing, and that a fictitious finishing point must of necessity be adopted; and our general experience tells us that such an adoption having been made, there is no difficulty in getting concordant results.

Effects of Variation in Temperature.

We used "copper sulphate," 50 c.c.; water, 150 c.c.; soda, 4 c.c., warmed; then added ammonia, 75 c.c., and sufficient water to make up the bulk to 300 c.c.; titrated, and took the temperature of the solution.

Temperature.. ..	10° C.	20° C.	35° C.	47° C.
"Cyanide" required	23·5 c.c.	23·3 c.c.	23·05 c.c.	22·85 c.c.

Effect of Ammonia and Ammonic Salts.

In our first experiments we found that 50 c.c. "copper sulphate" and 100 c.c. "ammonia" required 24·2 c.c. of potassic cyanide, whereas the same solution in which part of the ammonia had been converted into ammonic nitrate by the addition of 80 drops of strong nitric acid (sp. gr. 1·42) required 25·5 c.c.; clearly showing that ammonic nitrate interferes much more than its equivalent of ammonia does.

In order to determine whether nitrate, chloride, and sulphate of ammonia agree in their disturbing effect, we made a solution of sesquicarbonate of ammonia (4 grms. of the salt to 100 c.c.), and in three experiments added to the assay 100 c.c. of this, previously neutralised, in one case with sulphuric acid, in the second with nitric acid, and in the third with hydrochloric. In each case 50 c.c. "copper sulphate" and 100 c.c. of ammonia were used. Without ammonia salts 24·2 c.c. of "cyanide" were required, with ammonic chloride 25·7 c.c., with ammonic sulphate 25·7 c.c., and with ammonic nitrate 25·6 c.c. Strangely enough 100 c.c. of the solution of ammonic carbonate had the same effect, *i.e.*, 25·6 c.c. were required. But on repeating the experiments, and adding in each case 3 c.c. soda, this was no longer so. The results (a somewhat weaker cyanide solution was used) were—

Without ammonic salts ..	25·6 c.c.	cyanide	required.
With ammonic carbonate .	26·4	„	„
„ „ sulphate..	26·7	„	„
„ „ chloride ..	26·75	„	„
„ „ nitrate ..	26·75	„	„

From these it is a fair inference that the same quantity of ammonia has the same effect whether it be present as sulphate, nitrate, or chloride.

To show the effect of a gradually increasing quantity of ammonia we used 50 c.c. of "copper sulphate" diluted with water, and ran in "cyanide" until the precipitate first formed was re-dissolved. In the other experiments the same quantity of copper was used, ammonia was added, and the titration completed in the ordinary way.

Ammonia added—	0·0	2·0 c.c.	5·0 c.c.	10·0 c.c.	20·0 c.c.	30·0 c.c.
Cyanide required—	21·8 c.c.	22·5 c.c.	22·8 c.c.	23·0 c.c.	23·3 c.c.	23·4 c.c.

Ammonia added—	50·0 c.c.	100·0 c.c.
Cyanide required—	23·7 c.c.	24·2 c.c.

A similar series of experiments made to determine the effect of variation in the quantity of ammonic nitrate gave the following results:—

$AmNO_3$ added—	0·0	1 grm.	2 grms.	4 grms.	12 grms.
Cyanide required—	24·2 c.c.	24·6 c.c.	25·0 c.c.	25·4 c.c.	26·5 c.c.

In each case copper sulphate 50 c.c. and ammonia 100 c.c. were used.

Effects of Sodic Salts and Soda.

Experiments in which salts of soda and potash were added show that the sulphates, chlorides, and nitrates have little or no action, whilst the hydrates, carbonates, bicarbonates, sulphites, and nitrites have an important effect. It is curious that less cyanide is required in the presence of sodic sulphite.

We used copper sulphate 50 c.c., ammonia 75 c.c., soda 4 c.c. in each case; and added 6 grms., 12 grms., and 24 grms. of the salt whose effect we wished to determine. Without any such addition 24·9 c.c. of "cyanide" were required.

* During the experiments several lots of cyanide solution were made; and these were not all of exactly the same strength. Each series of experiments, however, was made with the same solution.

† The titration was performed in white glass stoppered bottles, holding when full about 340 c.c.

With *sodic sulphate* crystals the quantities of cyanide used were 24·9 c.c., 25·05 c.c., 25·1 c.c.

With *sodic chloride*, 24·95 c.c., 25·00 c.c., 25·1 c.c.

With *sodic nitrate*, 24·9 c.c., 24·9 c.c., 24·95 c.c.

The results thus got indicate the probable advantage of neutralising with soda instead of ammonia; in doing this it is scarcely possible to avoid using a slight excess of soda. It therefore became important to determine the effect of different quantities of this substance; in the experiments 50 c.c. copper sulphate and 75 c.c. ammonia were used.

Soda added—

0·0 1·0 c.c. 5·0 c.c. 10·0 c.c. 20·00 c.c. 50·00 c.c.

Cyanide required—

25·8 c.c. 26·0 c.c. 26·4 c.c. 26·9 c.c. 27·25 c.c. 28·00 c.c.

Conditions under which Proportional Results may be obtained.

Ammonic salts being absent, the temperature and mode of working being always the same, and only a very slight excess of soda being present, the problem is simplified; it only remains to determine the conditions in regard to ammonia and bulk under which the best results may be obtained.

When the copper, ammonia, and bulk vary, but maintain their relative proportions, the quantity of cyanide required is strictly proportional to the copper present.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
1.	10 c.c.	20 c.c.	60 c.c.	4·7 c.c.
2.	20 ,,	40 ,,	120 ,,	9·45 ,,
3.	40 ,,	80 ,,	240 ,,	18·9 ,,
4.	50 ,,	100 ,,	300 ,,	23·7 ,,

If the quantity of copper and the bulk remain constant, and the ammonia be increased, more cyanide is required.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
5.	50 c.c.	50 c.c.	300 c.c.	22·7 c.c.
4.	50 ,,	100 ,,	300 ,,	23·7 ,,
6.	50 ,,	200 ,,	300 ,,	24·5 ,,

The quantities of ammonia and copper remaining constant, the bulk increasing, less cyanide is required.

	Copper Sulphate.	Ammonia.	Bulk.	Cyanide.
7.	50 c.c.	100 c.c.	150 c.c.	24·0 c.c.
4.	50 ,,	100 ,,	300 ,,	23·7 ,,
8.	50 ,,	100 ,,	450 ,,	23·5 ,,

If, however, the addition of ammonia causes an increase, and an addition of water a decrease, in the quantity of cyanide required, it follows that there must be a solution of ammonia of such strength that the effect of the ammonia is neutralised by that of the water. The addition of such a solution to an assay should not affect the result; and in such a solution the quantity of cyanide required should be proportional to the copper present, so long at least as the latter does not vary within very wide limits.

In following up this last we tried two series of experiments:—1, containing in each assay 25 c.c. copper sulphate and 2 c.c. of soda; in 2, 75 c.c. copper sulphate and 6 c.c. "soda," with different quantities of ammonia. The quantities of cyanide required were as follows:—

"Ammonia"—

25·0 c.c. 40·0 c.c. 50·0 c.c. 75·0 c.c. 100·0 c.c. 150·0 c.c.

Cyanide required—

1. 11·2 ,, 11·5 ,, 11·7 ,, 11·9 ,, 12·1 ,, 12·5 ,,
2. 34·65 ,, 34·9 ,, 35·3 ,, 35·6 ,, 36·05 ,, 36·7 ,,

The results with 75 c.c. of ammonia are very closely what they would be if the cyanide used were proportional to the copper present. Another experiment, using 100 c.c. copper sulphate and 75 c.c. ammonia, required 47·6 c.c. of cyanide, which is exactly the proportional. This agreement is confirmed by the fact that throughout the series the error becomes gradually less, and then again increases in the opposite direction. Comparing the calculated results for the 2nd series with those found, we have—

Calculated	33·6	34·5	35·1	35·7	36·3	37·5
Found ..	34·65	34·9	35·3	35·6	36·05	36·7
Error ..	1·05	0·4	0·2	−0·1	−0·25	−0·8

We think these show conclusively that there is a certain strength of ammonia with which proportional results may be got, and that titrating in the manner we have described, in a slightly alkaline solution, this strength is 15 c.c. of strong ammonia (88°) to each 300 c.c. of solution.

In conclusion, we have to thank Messrs. Anstey and Hall, students in the Camborne Laboratory, for their care and trouble in performing a large number of the experiments.

ON THE PRECIPITATION OF TITANIC ACID.

By PETER T. AUSTEN and F. A. WILBER.

In the analysis of titaniferous ores by fusion with the carbonates and nitrates of the alkalies, the fused mass is soaked out with water, the solution acidified with chlorhydric acid, evoporated to dryness to render the silica insoluble, then taken up with chlorhydric acid and water, and filtered. In the residue consisting of silica, containing more or less ferric oxide, titanic acid, and phosphoric acid, the silicic acid is determined by expulsion with fluorhydric acid. The residue consisting of titanic acid, ferric oxide and phosphoric acid is then fused with an alkaline bisulphate, and the resulting solution added to the chlorhydric acid solution, which has been freed from platinum by treatment with hydrogen sulphide.

To determine the titanic acid in this chlorhydric acid solution it is necessary to precipitate an aliquot part of it with an excess of potassium hydrate (first oxidising the ferrous salts by potassium chlorate), filter off and wash the bulky gelatinous precipitate of ferric oxide, titanic acid, phosphates, &c., dissolve the mass in sulphuric acid, reduce and precipitate the titanic acid by boiling. It is not practicable to precipitate the titanic acid directly by boiling the chlorhydric acid solution, since the precipitation by this method is not complete, and when thus precipitated it runs through the filter-paper as soon as the wash-water ceases to be acid. If the wash-water is acidified with chlorhydric acid, the precipitate is more or less dissolved.* The filtration and washing of this precipitate is extremely irksome, and, like that of the basic acetates, is seldom really perfect.

On the other hand the method of decomposing the ores with an alkaline bisulphate, which yields at once a sulphuric acid solution, is often very tedious, on account of the stability of many ores toward this flux and the length of time that it frequently takes to remove the fused mass from the crucible, especially when potassium bisulphate has been used and the temperature has been too high, or not enough sulphuric acid has been added at the close. There are but few ores which are not decomposed by the alkaline carbonates and nitrates when the fusion is finished in a small Fletcher injection furnace, and if rightly handled during cooling the fusion will come out of the crucible in a few hours.

The results obtained by Streit and Franz† do not seem to have been utilised in the analysis of titaniferous iron ores. According to these authors, titanic acid may be precipitated from its chlorhydric acid solution in a form which can be easily filtered and washed, when to the solution one-third of its volume of sulphuric acid (containing one-sixth volume of H_2SO_4) and one-fifth of its volume of acetic acid are added. In using this method, however, we have found that when considerable amounts of chlorhydric acid were present, the addition of so much

* Rose, *Quant. Anal.*, 1871, 2, 313.

† *Journ. pr. Chem.*, 108, 65.

sulphuric acid prevented the precipitation of the titanic acid.

If also it is the intention to determine maganese by the beatuiful oxalate method of Classen* which does away with the tedious basic acetate procedure, it is of importance that but a small amount of sulphates should be present.† We were led, therefore, to experiment on the precipitation of titanic acid from its chlorhydric acid solution by the addition of acetic acid alone, and find that it answers the purpose in every way as well, if not better, than when a mixture of acetic and sulphuric acids is employed. The titanic acid is precipitated from its reduced solution on boiling as a flocculent precipitate which settles rapidly and well. The hot solution can be easily filtered without waiting for it to settle. The precipitate shows no tendency to run through the paper if washed with hot water acidified with acetic acid. In fact the addition of a little acetic acid to the wash-water, in cases were the titanic acid, precipitated by the usual method, shows a tendency to run through, stops it at once. The titanic acid when precipitated in the presence of acetic acid, from a chlorhydric solution containing ferrous salts of iron, is as free from iron as when precipitated by the usual method. It is rare that a precipitate of titanic acid is obtained perfectly free from iron in actual analysis when the solution contains a considerable amount of iron. In the presence of phosphates it always contains iron and phosphoric acid,‡ and has to be worked over again.

A number of experiments were made with titaniferous ores to ascertain if the precipitation of titanic acid from a chlorhydric solution in the presence of acetic acid was complete. In no case could the slightest trace of titanic acid be detected in the filtrates by means of tin and chlorhydric acid.

There are, of course, many modifications possible in the analysis of titaniferous ores, and various applications can be made of this method of precipitating titanium, but the following course seems to offer some advantages.

The ore is fused with alkaline carbonates and nitrates, and after taking up with water in the usual manner, is acidified with chlorhydric acid and evaporated to dryness to render the silica insoluble. It is then moistened with chlorhydric acid and treated with a little warm water till solution of the soluble parts has been effected, after which it is allowed to cool, and then diluted, without filtering, to 400—500 c.c. Sulphurous acid is next added, and then 50—60 c.c. of acetic acid. On boiling in the usual manner, the titanic acid will be precipitated in a flocculent and easily filterable state. The whole is then filtered and washed with hot water containing a little acetic acid. If the ore does not contain phosphoric acid this precipitate will be quite free from iron, and after expelling the silica by treatment with ammonium fluoride and sulphuric acid is generally pure enough to be taken as titanic acid, although in certain cases where the amount of titanic acid is small and the amount of iron large, a re-fusion is often necessary. In case the ore contains phosphates, the titanic acid precipitate will always contain iron and phosphoric acid. In this case, the residue, after expelling the silica with ammonium fluoride, can be fused with sodium carbonate and the fusion extracted with water, which dissolves the sodium phosphate and leaves the sodium titanate and ferric oxides.‖ This residue is then fused with a little sodium bisulphate, and the titanic acid precipitated after reduction by boiling. The filtrate containing the iron which was precipitated with the silica is now added to the filtrate from the original precipitation of the titanic acid, and the acidified filtrate from the fusion of the titanic acid with sodium carbonate,§ and the united solutions analysed for alumina, iron, manganese, calcium, and magnesia, after freeing it from platinum by precipitation with hydrogen sulphide. —*Amer. Chem. Journ.*

* *Fres. Zeit.* 18, 175.
† *Fres. Zeit.* 18, 187.
‡ Bogardus, *Am. Journ. Sci.*, 3, 8, 334.
‖ Drown and Shimer, *Am. Journ. Sci.*, 4, 6.
§ This is hardly necessary unless phosphoric acid is to be determined in this solution

BEHAVIOUR OF THE ACETATES OF CHROMIUM IRON, AND ALUMINIUM.

By B. REINITZER.

If a solution of chromium sulphate or chloride is mixed with an excess of sodium acetate and boiled no deposit is formed even after hours of ebullition, however concentrated the solution, and however much sodium acetate is added. If the solution is boiled for a short time only it takes on cooling a violet colour.

The solution of a chromic salt thus treated is found to have assumed decidedly new properties. Caustic alkalies, ammonia, ammonium sulphide and carbonate, alkaline carbonates, sodium phosphate, baryta-water and barium carbonate produce in the cold not the slightest turbidity, whether added in small quantities or in excess. Caustic alkalies and baryta change the colour of the solution, at first to an olive-green, and then to an emerald-green, and after standing for twelve hours the liquid congeals to a green jelly. On adding ammonia no immediate change of colour occurs; after about 48 hours the liquid is converted to a violet jelly. Ammonium sulphide and carbonate act in the same manner after the lapse of several days. If the mixture is boiled after the addition of the above-mentioned reagents there appears, according to the strength of the alkaline reaction and the quantity added, sooner or later a precipitate; sodium phosphate alone occasions no deposit.

If the solution contains along with chromic oxide, ferric oxide, and alumina, the chromium acetate imparts its passivity to certain quantities of the ferric and aluminium acetates. Neither by ebullition nor by the addition of caustic alkalies, ammonia, &c., can certain quantities of ferric and aluminium acetate be detected in presence of chromic acetate. Ammonium sulphide makes an exception as far as iron is concerned, since it effects a slow but complete precipitation of iron sulphide. A given quantity of chromium can preserve a given quantity of iron and alumina from precipitation, but larger quantities only if the solution of chromium has been boiled with the sodium acetate before the addition of the solution of iron and aluminium.

If the chromic solution is merely mixed with sodium acetate in the cold the chromium can at first be precipitated in the cold by the above-named reagents. On standing for a day the liquid acquires the same passivity as it would have done on boiling.

From the above it appears that the method of separating ferric and aluminum salts in the form of basic acetates entirely loses its applicability in presence of chromic salts. —*Zeitschrift für Analyt. Chemie.*

Application of Solution of Borax for Extracting Colouring-Matters.—R. Palm.—For isolating alizarin and purpurin from garancine the author digests in a solution of borax saturated in the cold until a deep blood-red solution is formed. The liquid is filtered and completely precipitated with sulphuric, hydrochloric, or acetic acid. The bulky violet-brown precipitate is boiled for a long time with a saturated solution of alum. From the filtered decoction alizarin is deposited on cooling and filtered off. The filtrate deposits alizarin on the addition of concentrated sulphuric acid. The author also applies borax for the extraction of santaline from sanders wood, and a violet colouring-matter, not identical with carmine, from cochineal.—*Zeitschrift fur Anal. Chemie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
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BARIUM.

For determining the atomic weight of barium we have a series of six ratios, established by the labours of Berzelius, Turner, Struve, Pelouze, Marignac, and Dumas. Andrews† and Salvetat,‡ in their papers upon this subject, gave no details nor weighings; and, therefore, their work may be properly disregarded. First in order in point of importance, if not first chronologically, is the ratio between silver and anhydrous barium chloride, as determined by Pelouze, Marignac, and Dumas.

Pelouze,‖ in 1845, made the three subjoined estimations of this ratio, using his well known volumetric method. A quantity of pure silver was dissolved in nitric acid, and the amount of barium chloride needed to precipitate it was accurately ascertained. In the last column I give the quantity of barium chloride proportional to 100 parts of silver:—

3·860 grms.	$BaCl_2$ ppt.	4·002 grms.	Ag	96·452
5·790	,,	6·003	,,	96·452
2·895	,,	3·001	,,	96·468

Mean 96·4573±0·0036

Essentially the same method was adopted by Marignac§ in 1848. His experiments were made upon four samples of barium chloride as follows. A, commercial barium chloride, purified by re-crystallisation from water. B, the same salt, calcined, re-dissolved in water, the solution saturated with carbonic acid, filtered, and allowed to crystallise. C, the preceding salt, washed with alcohol, and again re-crystallised. D, the same, again washed with alcohol. For 100 parts of silver the following quantities of chloride were required:—

A.
96·356
96·345
96·362

Mean 96·3543 ± 0·0033

B.
96·356
96·452

Mean 96·354 ± 0·0013

C.
96·358
96·363

Mean 96·3605 ± 0·0017

D.
96·346
96·384
96·361
96·377

Mean 96·367 ± 0·0057

Dumas¶ employed barium chloride prepared from pure barium nitrate, and took the extra precaution of fusing the salt at a red heat in a current of dry hydrochloric acid gas. Three series of experiments upon three samples of chloride gave the following results:—

Series A.

1·7585 grms.	$BaCl_2$ =	1·826 grms.	Ag.	Ratio 96·303
3·842	,,	3·988	,,	96·339
2·1585	,,	2·2405	,,	96·340
4·0162	,,	4·168	,,	96·358

Mean 96·3325 ± 0·0068

Series B.

1·6625 grms.	$BaCl_2$ =	1·727 grms.	Ag	Ratio 96·265
2·4987	,,	2·5946	,,	96·304
3·4468	,,	3·579	,,	96·306
4·0822	,,	4·2395	,,	96·290
4·2062	,,	4·3683	,,	96·289
4·4564	,,	4·629	,,	96·271
8·6975	,,	9·031	,,	96·307

Mean 96·2902 ±0·0043

Series C.

2·2957 grms.	$BaCl_2$ =	2·3835 grms.	Ag	Ratio 96·316
4·1372	,,	4·293	,,	96·371
4·2662	,,	4·430	,,	96·303
4·4764	,,	4·647	,,	96·329
5·6397	,,	5·852	,,	96·372

Mean 96·3382 ±0·0096

We have now eight series of experiments upon this ratio, representing thirty distinct estimations. Combining, we get a general mean as follows:—

Pelouze	96·4573 ±	0·0036
Marignac, A	96·3543	0·0033
,, B	96·3540	0·0013
,, C	96·3605	0·0017
,, D	96·3670	0·0057
Dumas, A	96·3325	0·0068
,, B	96·2902	0·0043
,, C	96·3382	0·0096
General mean	96·3596	0·0009

The ratio between silver and crystallised barium chloride has also been fixed by Marignac.* The usual method was employed, and two series of experiments were made, in the second of which the water of crystallisation was determined previous to the estimation. Five grammes of chloride was taken in each determination. The following quantities of $BaCl_2.2H_2O$ correspond to 100 parts of silver:—

A.	B.
113·109	113·135
113·135	113·122
113·097	113·060
Mean 113·114 ± 0·0074	Mean 113·106 ± 0·0154

The general mean from both series is 113·113±0·0067.

The direct ratio between the chlorides of silver and barium was early established both by Berzelius† and Turner.‡ Berzelius found that 100 parts of dry barium chloride gave of silver chloride:—

138·06
138·08

Mean 138·07 ± 0·007

Turner made five experiments, with the following results:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Chemical Gazette*, October, 1852.
‡ *Comptes Rendus*, 17, 318.
‖ *Comptes Rendus*, 20, 1047. *Journ. f. Prakt. Chem.*, 35, 73.
§ *Arch. d. Sci. Phys. et. Nat.*, 8, 271.
¶ *Ann. Chem. Pharm.*, 113, 22. 1860. *Ann. Chim Phys.* (3), 55, 129

* *Journ. f. Prakt. Chem.*, 74, 212. 1858.
† *Pogg. Anal.*, 8, 177.
‡ *Phil. Trans.*, 1829, 291.

137·45
137·54
137·70
137·62
137·64

Of these, Turner regards the fourth and fifth as the most exact. These give a mean of 137·63 ±0·007, while the other three are in mean 137·563 ± 0·049. Combining Berzelius's figures with those of Turner, we get as follows:—

Berzelius	138·07	± 0 007
Turner, 1, 2, 3	137·563	0·049
,, 4, 5	137·63	0·007
General mean	137·841	± 0·0047

Incidentally to some of his other work, Marignac* determined the percentage of water in crystallised barium chloride. Two sets of three experiments each were made, the first upon five grammes and the second upon ten grammes of salt. The following are the percentages obtained:—

A.	B.
14·790	14·80
14·796	14·81
14·800	14·80
Mean 14·795 ± 0·0019	Mean 14·803 ± 0·002

General mean of both series.. 14·799 ± 0·0014.

The ratio between barium nitrate and barium sulphate has been determined only by Turner.† According to his experiments 100 parts of sulphate correspond to the following quantities of nitrate:—

112·060
111·990
112·035
Mean 112·028 ± 0·014 .

For the similar ratio between the sulphate and the chloride there are experiments by Turner, Berzelius, Struve, and Marignac. Turner‡ found that 100 parts of chloride ignited with sulphuric acid gave 112·19 parts of sulphate. By the common method of precipitation and filtration a lower figure was obtained, because of the slight solubility of the sulphate. This point bears directly upon many other atomic weight determinations.

Berzelius,‖ treating barium chloride with sulphuric acid, obtained the following results in $BaSO_4$ for 100 parts of $BaCl_2$:—

112·17
112·18
Mean 112·175 ± 0·034

Struve,§ in two experiments, found—

112·0912
112·0964
Mean 112·0938 ± 0·0018

Marignac's¶ three results are as follows:—

8·520 grms. $BaCl_2$ gave	9·543	$BaSO_4$.	Ratio	112 067
8 519 ,,	9·544	,,		112·032
8·520 ,,	9·542	,,		111·995
			Mean	112·011 ± 0·0071

* *Jour. f. Prakt. Chem.*, 74, 212. 1858.
† *Phil. Trans.*, 1833, 538.
‡ *Phil. Trans.*, 1829, 291.
‖ *Pogg. Annal.*, 8, 177.
§ *Ann. Chem. Pharm.*, 80, 204. 1851.
¶ *Journ. f. Prakt. Chem.*, 74, 212. 1858.

Rejecting Turner's single result as unimportant, we may combine the other series:—

Berzelius	112·175 ± 0·0034
Struve	112·0938 0·0018
Marignac	112·011 0·0071
General mean ..	112·106 ± 0·0015

The data from which we are to calculate the atomic weight of barium may now be tabulated as follows:—

(1.) $Ag_2 : BaCl_2 :: 100 : 96·3596 \pm 0·0009$
(2.) $Ag_2 : BaCl_2.2H_2O :: 100 : 113·113 \pm 0·0067$
(3.) $BaCl_2 : 2AgCl :: 100 : 137·841 \pm 0·0047$
(4.) Per cent of H_2O in $BaCl_2.2H_2O$, 14·799 ± 0·0014
(5.) $BaSO_4 : BaN_2O_6 :: 112·028 \pm 0·014$
(6.) $BaCl_2 : BaSO_4 :: 100 : 112·106 \pm 0·0015$.

From these ratios, with the aid of the atomic weights already established, we can immediately calculate four independent values for the molecular weight of $BaCl_2$:—

From (1)	$BaCl_2$ = 207·510	± 0·019
From (2)	,, 207·662	0·027
From (3)	,, 207·536	0·017
From (4)	,, 206·837	0·045
General mean ..	,, 207·505	± 0·011

We have here an interesting example of the compensation of constant errors. Ratios (2) and (4) both represent work done by Marignac upon barium chloride containing water of crystallisation. If now, as is not improbable, the salt contained a trifling excess of water, the molecular weight of barium chloride as calculated from (2) would come out too high, while on the other hand the result from ratio (4) would err in the opposite direction. In point of fact, the two results in the present calculation nearly compensate each other, and, on account of their relatively high probable errors, they exert but an unimportant influence upon the general mean.

In conclusion, we have three independent values for the atomic weight of barium:—

From mol. wt. of $BaCl_2$	Ba = 136·765	± 0·031
From ratio (5)..	,, 136·795	0·364
From ratio (6)..	,, 136·595	0·309
General mean ..	,, 136·763	± 0·031

If O = 16, then Ba = 137·007. In other words, the ratio between oxygen and barium is almost an exact ratio between two whole numbers.

In the above discussion it will at once be noticed that the second and third values for Ba have very high probable errors, and that they therefore exert almost no influence upon the general mean. This fact by no means renders them worthless, however, for at the lowest estimate they are useful in confirmation of the better determinations. It is also highly probable that the method of discussion, rigidly carried out, does not do them absolute justice.

Bone-Black Superphosphate.—Prof. Fr. Farsky.—The author's conclusions are that superphosphate goes back in the soil the more rapidly, the more calcium carbonate is present. The more water circulates in the soil the less is the reversion. Superphosphate of a coarse texture is less liable to reversion than that of a fine grain. As most seeds complete their germination in the soil in seven to fourteen days, it appears that in lime soils plants obtain the phosphoric acid of their nourishment chiefly, if not entirely, from the calcium phosphate soluble in ammonium citrate. In an experimental field fine-grained superphosphate gave a less advantageous result than coarser qualities. Kladno phosphate gave in three cases a better result than superphosphate, except with potatoes. Precipitated phosphate did not act as well as the other phosphates.—*Biedermann's Centralblatt.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 7, August 13, 1883.

On β-Butyl-glycol.—A. Wurtz.—The author compares the β-butyl-glycol of Kekulé obtained as an accessory product of the hydrogenisation of aldehyd with the compound formed on submitting a dilute solution of pure aldol to the action of sodium amalgam, and establishes their identity. He also gives an account of the acetine of butyl-glycol, and of butylene di-iodide.

The Critical Point of Oxygen.—E. Sarrau.—The author has determined by calculation the critical pressure and temperature of this gas, and obtains values closely approximating to those which M. Wroblewski has found experimentally.

Combination-heat of Oxygen and Carbon.—A. Boillot.—The author considers that the essential principle in thermo-chemical determinations relates to the quantity of heat proper to each of the components entering into combination or separating from each other in case of decomposition. Hitherto the heats measured have been only the sums or the differences given by the elements constituting the compounds. For the present the author deals with this problem merely as it regards carbon monoxide and dioxide.

Composition of the Asphalt or Bitumen of Judea.—B. Delachanal.—This bitumen contains 3·14 per cent of sulphur, which cannot be, for the greatest part at least, present in the state of metallic sulphides, since the quantity of ash left on incineration did not exceed 0·273 per cent. On distillation, the bitumen yields oils having a close analogy with those obtained by the distillation of crude petroleum. Some paraffin was also produced.

On Flours.—M. Balland.—From one and the same flour variable quantities of gluten may be obtained according to the manner of operating. The variation depends especially on the degree of hydration of the gluten, and on the washing which it undergoes. To avoid errors the following procedure is recommended. Make a paste with 50 grms. flour and 20 to 25 grms. water, let it lie for twenty-five minutes, and divide it into two equal portions; extract the gluten from the one immediately, and that from the other an hour afterwards; weigh the gluten after having pressed it strongly by hand until the water runs out clear; then wash again for five minutes, and weigh afresh. The mean of the four operations is then taken.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., July, 1883.

This number does not contain any chemical matter.

Bulletin de la Société Chimique de Paris. No. 3, August 5, 1883.

Certain Reactions of Tellurium.—Eug. Demarçay.—The tellurides are generally described as having a reddish violet colour in solution. It seems, however, that the pure tellurides are slightly yellowish, the violet colour being due either to poly-tellurides, or to a tellurium sub-oxide. If we boil the strongly alkaline solution of a telluride with a reducing agent, such as phosphorus or a hypophosphite, the violet colour disappears, giving place to a very faint yellow. If the air is allowed to enter, the colour reappears. This experiment may be modified by replacing the violet solution by the strongly alkaline solution of a tellurite. There is then produced at first an intense violet solution, which disappears afterwards, but is restored on admitting the air. If the solution is not very alkaline a portion of the tellurium appears to be eliminated as hydro-telluric acid. It seems, then, that the violet compound precedes the formation of the telluride, and is due to some sub-oxide. Mr. Divers, who has recently prepared a sub-oxide, declares it insoluble in alkaline liquids. Perhaps this is a not the case when it is formed in a finely-divided state. Wœhler prepared certain methylated and ethylated tellurium compounds by setting out, from the methyl and ethyl tellurides, bodies not readily obtained. They may be produced more readily by treating powdered tellurium for forty-eight hours with methyl-iodide at 80°.

A Product of the Oxidation of Di-ethyl-benzine.—MM. Allen and Underwood.—This paper is apparently taken from some English journal.

Note on Gladding's Method of Determining Reverted Phosphates.—M. Millot.—From the *Moniteur Scientifique.* Mr. Gladding's process gives results capable of comparison with those of the method commonly employed in France, which consists in treating 1 grm. of super-phosphate with 40 to 50 c.c. of ammonium citrate, saturated and strongly ammoniacal, and allowing them to react for twelve to fifteen hours.

Bibasic Sodium Glycolate.—M. de Forcrand.—The author determines the thermic conditions under which this salt is formed.

Methylation of Phenols.—Camille Vincent.—The liquid methyl chloride now met with in commerce serves for the methylation of phenols in a simple and rapid manner. The phenol to be operated upon is combined with potassa or soda, the product is dried, and treated at a suitable temperature with gaseous methyl chloride. The methylated phenol formed distils over if the temperature is sufficiently high.

The Pyrometer of Boulier Bros.—Ch. Lauth.—The apparatus of MM. Boulier is based upon a very simple principle; the thermometric observation of the temperature assumed by a rapid current of water circulating in the medium (furnace, &c.) which is under observation. The pyrometer is composed of three distinct parts: the explorer, the reservoir, and the interruptor. The explorer is the most interesting part of the apparatus. It is a small cylinder formed of very thin copper a few centimetres in length; one of its extremities is closed, and the other ends in two tubes, one of which is connected with a reservoir of water, while the other is in contact with a thermometer. These two tubes are inclosed in a metal cylinder, which serves as a refrigerator, and which is fed by the reservoir of water. This cylinder is 1 metre in length and 3 centimetres in diameter. The reservoir needs no special description; it is fitted with a ball-cock in order to maintain the water at a constant level. The interruptor is composed of a small balance, which is in equilibrium as long as the current of water acts regularly, but on the least interruption in the circulation of the water it sets in action an electric alarum, and by means of an electro-magnet even cuts off the supply of water. In order to make use of this pyrometer the explorer is placed in communication with the reservoir of water by means of a flexible tube, and after having ascertained that the circulation is regular the explorer is placed in the furnace or muffle, the temperature of which has to be observed; it is fixed firmly in the door or some other part of the furnace, and a few moments afterwards the observations are begun. The water coming from the reservoir circulates in the apparatus; it is heated by contact with the flames or the hot air, which it meets and shows by the thermometer the changes of temperature which it undergoes.

Researches on Mesitylene.—G. Robinet and Albert Colson.—The authors prove that mesitylene dichloride and dibromide are identical with the dihydrochloric and

dihydrobromic ethers of mesitylenic glycol, a body as yet unknown.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 7.

Experiments with Potash Manures. — Prof. Fr. Farsky.—Pure potash salts applied along with bone-dust reduced the crops in all the experiments. The chloride had a less injurious action than the sulphate. The after effects in the second year were favourable with barley and buck-wheat. The Stassfurt manures were tried upon rye, oats, barley, hemp, clover, carrots, &c., with the following results: With barley, and partially with rye and clover, the action was unfavourable. An autumn dressing was found preferable to one in the spring.

Action of Rain, Dew, and Watering upon Plants. —Prof. Julius Wiessner.—The application of moisture to the leaves promotes transpiration and accelerates the movement of the sap. This process may be injurious if the soil does not contain sufficient moisture.

Experiments on the Influence of the Quantity of Seed and the Use of Artificial Manures upon the Yield and the Composition of Oats.—O. Beseler and Prof. M. Maercker.—A sowing of 22 lbs. oats per acre, notwithstanding abundant manuring, does not give so heavy a crop as a sowing of 38 lbs. By a rational manuring the supply of proteine in the harvest can be almost doubled. Of the nitrogen applied in these experiments about 55 per cent was recovered in the harvest.

Injurious Action of Ammonium Sulphocyanide. —Prof. M Maercker.—An addition of 1 per cent of this compound to superphosphate is harmless. One hundred kilos. per hectare had no injurious action upon oats.

Action of Brine upon Trichinæ.—M. Collin.—The trichinæ in the superficial parts of hams, &c., survived for fifteen days in brine. In a heavy ham the parasites were not entirely destroyed without exposure to brine for two months.

Cosmos les Mondes.
No. 14, August 4, 1883.

A Reclamation of Priority.—Dr. D. Tommasi.—With reference to a memoir by M. F. Brame, which appears in No. 22 of the *Revue Scientifique*, the author points out that he has shown at earlier dates, in several communications presented to the Academy of Sciences, that the quantity of calories transmissible in the circuit in the form of electric energy—or, more exactly, of chemical energy, varies according to the nature of the positive electrode of the battery.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 3, 1883.

Testing Petroleum.—F. Beilstein.—This paper requires the two accompanying illustrations.

Certain Reactions of Ozone.—A. Wagner.—1. With Anthracene.—The author, considering that anthracene is oxidised to anthraquinone by hydrogen peroxide, tried to obtain the same result with ozone. Some filter-paper was steeped in a boiling solution of anthracene in ether, allowed to evaporate, and the paper, moistened with water, was then suspended for twenty hours in a bottle containing phosphorus partially covered with water. The paper was boiled up with soda-lye and zinc powder, and the boiling solution was quickly filtered. The filtrate had a strong red colouration from the formation of anthranol, and gave with hydrochloric acid a yellowish white precipitate,—a proof that anthraquinone had been formed.

2. With Aniline Hydrochlorate.—If filter-paper recently saturated with aniline hydrochlorate is suspended in a bottle containing air strongly ozonised by means of phosphorus, it soon takes a pure brown colour without a reddish tone. If strong electric sparks are caused to strike through atmospheric air in presence of such paper, it became a reddish brown, and on subsequent exposure to the air it assumed a decided red. The same experiment succeeded, though more slowly, with pure oxygen in place of atmospheric air.

3. With Diphenylamine.—Paper saturated with an alcoholic solution of diphenylamine, on exposure to air ozonised with phosphorus, took a pale brown colour, without previously assuming a lemon-yellow tint. If similar paper is exposed to air, or oxygen ozonised by electric sparks, a lemon or orange colour is produced which does not turn to a brown on prolonged action.

4. On Sulpho-diphenylamic Acid.—If a few drops of this acid dissolved in concentrated sulphuric acid are poured into a glass filled with air or with pure oxygen, and if electric sparks are allowed to strike through the air in the glass the acid is quickly turned to an intense blue colour. The same acid, on exposure to air ozonised by means of phosphorus, only took a greenish blue on the sides of the capsule.

Chemical Character of the Violet Colour in Ergot, and its Detection in Flour.—R. Palm.—The author shows that the colouring-matter in ergot is not, as commonly supposed, combined with alkaline earths, and describes its behaviour with solvents and reagents. For its detection in meal, the sample, previously dried, is extracted at 30° to 40° with 10 to 15 parts alcohol at 35° to 40° Tralles with the addition of a few drops of ammonia. The mass is then carefully pressed out, the liquid thoroughly precipitated with basic lead acetate, the precipitate is collected on a filter, pressed between folds of bibulous paper, and the residue, whilst still moist, digested with a saturated solution of borax at a very gentle heat. The solution, if ergot was present, takes a characteristic violet colour. For detecting ergot in bread the sample is dried and powdered, and heated gently for five to ten minutes with 10 to 15 parts of alcohol at 40° Tralles. The liquid is filtered through animal charcoal, the filtrate evaporated almost to dryness on the water-bath, and the residue, still moist, is extracted with alcohol at 40°. The solution is again filtered over animal charcoal, and perfectly precipitated with basic or neutral lead acetate.

Detection of Asparagine and Glutamine in the Juices and Extracts of Plants.—E. Schulze.—The author bases a process for the detection of these amides on their precipitation by mercuric nitrate. The juices or extracts to be tested are treated first with lead acetate as long as a precipitate is formed, and to the filtrate is added a solution—not too acid—of mercuric nitrate. The precipitate thus obtained is filtered and washed, and decomposed by sulphuretted hydrogen. The filtrate from the mercury sulphide is then further examined. If it contains either of the above amides it evolves ammonia if heated with potassa or baryta-water.

Determination of Ammonia in Vegetable Juices and Extracts.—E. Bosshard.—This paper requires the accompanying illustration.

Alcohol in the Brain in Cases of Drunkenness.—Dr. H. F. Kuijper.—The author describes the procedure by which he established that two persons found drowned must have been in a state of alcoholic intoxication when they fell into the water.

Replacement of Hydrogen Sulphide by Ammonium Hyposulphite in Systematic Qualitative Analysis.—Anton Orlowski.—This memoir will be inserted in full.

New Method for the Determination of Nitrogen in Organic Bodies.—J. Kjeldahl.—See page 101.

Volumetric Determination of the Fatty Matter in Milk.—Prof. Leo Liebermann.—This paper will be inserted at length.

Determining the Value of Commercial Potassium Iodide.—W. Lenz.—The author has tested the method of Carles (titration with mercuric chloride), and finds it

useless, the result fluctuating by 0·2 to 0·57 per cent with the difference of a single degree in temperature.

Purification of Sulphuretted Hydrogen for Chemico-Legal Investigations.—W. Lenz.—This paper will be inserted at length.

Distillatory Apparatus for Determinations of Alcohol.—Dr. B. Landmann.

Water-Bath with Constant Level.—C. Klement.—These two papers cannot be usefully abridged without the accompanying illustrations.

An Indicator which shows directly the Neutral Concluding-point in Alkalimetry and Acidimetry.—A. Gawalovski.—If alcoholic solutions of phenol-phthaleine and dimethyl-aniline orange (so-called methyl-orange) are mixed together we obtain an indicator which is turned a deep red by a drop of normal alkali in excess, and to a rose colour by a drop of normal acid in excess. If the neutral point is exactly reached the liquid containing this indicator appears of a light lemon-yellow. The changes of colour occur in four to five seconds. The mixture of the two colouring-matters retains its sensibility for at least five days.

Presence of Arsenic in Glass as a Source of Error in the Detection of Arsenic.—W. Fresenius.—Already noticed.

Apparatus and Methods for Gas Analysis.—The improvements of Geppert, Sokoloff, Pszczolka, and Lunge cannot be intelligibly described without the accompanying illustrations; those of E. W. Morley and A. H. Elliot are taken from the CHEMICAL NEWS.

Determination of Hydrogen Phosphide in Gaseous Mixtures.—J. Riban.—Hydrogen phosphide is readily and completely absorbed by a hydrochlorous solution of cuprous chloride.

Heating Apparatus for Laboratory Uses.—J. A. Kaiser.—The author has devised an ignition-furnace, resembling in many respects that of Perrot; a special furnace for heating substances in closed iron tubes at high pressure, and a stove for drying and evaporation.

Quantitative Separation of Potassium and Sodium from Ferric Oxide, Alumina, Lime, and Magnesia in Silicates.—W. Knop.—(See page 110.)

Test for the Purity of Magnesium Pyrophosphate.—B. Tollens.—If the precipitate after ignition is covered for some hours with silver nitrate in the cold, and then heated, it turns yellow if basic magnesium or calcium phosphate, or both these salts, or the citrates of these bases, should be present.

Precipitation of Alumina.—A. Guyard.—If alumina is precipitated in presence of glycerin it falls in dense flocks which are easily washed.

Behaviour of Chromic, Ferric, and Aluminium cetates.—B. Reinitzer.—(See page 114.)

Volumetric Determination of Ferrous Oxide in Hydrochloric Solution by Means of Permanganate.—N. W. Thomas.—The disturbing effect of hydrochloric acid can be obviated if the solution to be titrated is mixed with an aqueous solution of lead chloride.

UNIVERSITY COLLEGE, BRISTOL.
CHEMICAL DEPARTMENT.

Professor—W. RAMSAY, Ph.D. Lecturer—SYDNEY YOUNG, D.Sc

The SESSION 1883-84 begins on 8th OCTOBER. Lectures on Inorganic, Organic, and Technical Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening, Lectures on Inorganic Chemistry at reduced fees are delivered; and a special Course of Lectures on Technical Chemistry is also given, with the co-operation of the Worshipful Company of Clothworkers. Several Scholarships are tenable at the College.

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The next ANNUAL GENERAL MEETING will be held at SOUTHPORT, commencing on WEDNESDAY, September 19.

President-Elect:—
ARTHUR CAYLEY, Esq., M.A., LL.D., F.R.S., V.P.R.A.S., Sadlerian Professor of Mathematics in the University of Cambridge.

NOTICE TO CONTRIBUTORS OF MEMOIRS.—Authors are requested to give early notice of their intention to offer Papers.

Information about Lodgings and other Local arrangements may be obtained from the Local Secretaries, Town Hall, Southport.

T. G. BONNEY, Secretary.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1883-4 will commence on Monday, October 1st, 1883. The Prizes for the past Session, and the Nursing Probationers' Prizes, will be distributed on Tuesday, October 9th, at 8 p.m., by Professor Huxley, P.R.S., who will also make an Address, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

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SESSION 1883-84.

I. DEPARTMENT OF ARTS AND LAW.
II. DEPARTMENT OF SCIENCE AND ENGINEERING.

Candidates for admission in these Departments must not be under 14½ years of age, and those under 16 will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on the 28th September.

III. DEPARTMENT OF MEDICINE AND SURGERY.

Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

The SESSION in DEPARTMENTS I., II., and III., will COMMENCE on the 2ND OCTOBER.

IV. DEPARTMENT FOR WOMEN (223, Brunswick Street).

The Session will commence on the 8th October.

V. EVENING CLASSES.

The Session will commence on the 15th October. New Students will be admitted on the 10th, 11th, and 12th October, between 6.30 and 9 p.m.

ENTRANCE EXHIBITIONS are offered for competition at the beginning of the Session in *Classics, Greek Testament. Mathematics. English* and *History*, and also a *Dauntesey Medical Scholarship*, value £100.

Prospectuses of the several Departments may be obtained at Mr. CORNISH'S, Piccadilly, Manchester; and they will be forwarded from the College, on application.

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AND
JOURNAL OF PHYSICAL SCIENCE.

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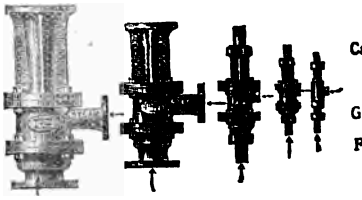

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WOODCOCK and SONS, Secretaries.

West View, Haslingden,
29th August, 1883.

THE CHEMICAL NEWS.

Vol. XLVIII. No. 1242.

ADDRESS TO STUDENTS.

It has been our custom at this time of the year to throw out a few hints in the hope that they might be of some use to persons beginning or continuing the study of chemistry. We have repeatedly insisted upon the necessity of thoroughness, of a thing-knowledge of the science, as distinguished from a mere word- or book-knowledge. We have advised the student to acquire facts and principles by actual work in the laboratory, using book mainly for the purpose of collating and arranging the results of experiment and observation. At the same time we have not failed to recognise the difficulty of combining such thorough thing-knowledge with that power of answering questions which the examinational system, unhappily dominant in England, as in China, requires. We have admitted that the man who knows and does not pass is a misfortune to himself and his teachers, whilst he who passes and does not know, —the more common case,—is a discredit to Science and to mankind. But we have not been able to write out any neat and simple formula for combining these two ends, and securing success to the meritorious, or merit to the successful. We must therefore leave this subject to the judgment and the conscientiousness of each teacher, and to the honest endeavour of each student.

At other times we have asked young men commencing the study of chemistry to reflect well what are their motives for so doing? We have cautioned them that though a knowledge of the science is of great practical advantage in many callings, yet that it does not under ordinary circumstances form the basis of a distinct and independent profession. The emoluments, even of a very able analytical chemist, may fall below those of a bricklayer, whilst he is denied the privilege, open to every other profession under the sun, of sometimes blundering.

For the present, then, we wish to plead the cause of pure chemistry, and to call attention to the departments where more work is urgently required. True, such work is in great part beyond the reach of the student. But he may at least seek to qualify himself for it, and keep it in view as an ultimate object.

We boast in these days of our organic syntheses. We are able to make in the laboratory, and even in the workshop, not a few compounds which a century ago were obtained by the intervention of animal or vegetable life. But if we ask what are our raw materials, our starting-points, we must own that the scientific meaning of these results is much abated. In very few cases can we take the elements as they occur in the free state, or in purely inorganic bodies, and unite them into organic compounds. Our vaunted alizarin, artificial indigo, vanillin, and the like, are formed merely from the residues of living beings. To increase the small number of organic compounds which can be truly formed from inorganic matter would be a most worthy life-task. Whether or not it might prove commercially remunerative is, of course, from our present point of view, totally beside the question. Not till we can really produce all chemical individuals—as distinct from physiological organisms — from purely inorganic matter, can we truly venture to say that the chemical boundary between the organic and the inorganic is cancelled.

Or the student may look in a different direction. In chemistry, as well as in other sciences which we are not called upon to discuss, we find a vast and, we fear, an increasing mass of assumptions, which, if capable of demonstration, are certainly as yet unproven, of terms to which no definite meaning is attached, and even of facts, or what pass for such, sadly in need of verification. Here, then, is work remaining to be done which in quantity is all but infinite, and in importance is second to none. It is surely to be deplored that the philosophy of chemistry is so much neglected. It would be, indeed, idle to overlook the importance of the contributions in that direction which have been furnished by Mendelejeff, by Lothar Meyer, Newlands, and others. But the great mass of chemists fancy that if they have formed and analysed some dozen compounds hitherto non-existent and assigned them "paper constitutions," they have fulfilled all righteousness. Surely so long as we have no reason to suppose ourselves acquainted with all the simple bodies existing in our earth, so long as the claims of not a few substances to the elementary rank are doubtful, whilst the questions of Prout's law, of the foundations of thermochemistry, and even of the indecomposability of the reputed elements, are undecided, we may boldly assert that the routine work of the majority of laboratories, however useful and valuable, is not all, nor even the highest that may be fairly demanded. We must look to our students for a chemistry of the future, which shall arrive at the greatest results by not professing to be wise beyond what is demonstrated.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 14th, 1884. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate,

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

Intermediate Examination in Science.

The Intermediate Examination in Science will be held in July, 1883.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the Intermediate Examination in Science in all its subjects may be examined at the Honours Examination next following the Intermediate Examination in Science at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the Intermediate Examination in Arts, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the Intermediate Examination in Science, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday (with Saturday if necessary) in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

B.Sc. Examination.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the B.Sc. Examination, and has not previously passed the B.A. Examination, may be examined at the Honours Examination next following the B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

Doctor of Science.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the Intermediate Examination in Science, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

BRANCH IV. OF PHYSICAL SCIENCE.
INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.
Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.
Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1883.

No Candidate is admitted to this examination until he has passed the Matriculation Examination,* and notice must be given to the Registrar at least 14 days before the commencement of the examination. The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

GILCHRIST SCHOLARSHIPS.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

3. A Scholarship of Fifty Pounds per annum, tenable for three years, is also annually awarded to that Candidate in the Honours Division at the June Matriculation Examination who shall stand highest of the Candidates previously approved by the Principal of University College, Bristol; and who intends to study at that College with a view to graduation in one of the Faculties of the University of London. (N.B.—This Scholarship is open to Women.) Further particulars may be obtained on application to the Principal of University College, Bristol.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination also admits a Candidate to the Mathematics of the Intermediate Examination in Science, *if taken at the same time*.

other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year:—

MICHAELMAS TERM, 1883.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 11.

Physical Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 15.

Elementary Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 13.

Metals, by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 12.

Organic Chemistry (advanced), by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 11.

Elementary Physical Chemistry, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 15.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 12.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 18.

Practical Chemistry, by the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, and Sidney Colleges. Daily. Begin Oct. 11.

LENT TERM, 1883.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 24.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 25.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Jan. 26.

Non-metallic Elements, by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 25.

General Principles of Chemistry (advanced), by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 26.

Elementary Organic Chemistry, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Jan. 25.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Jan. 25.

Chemical Philosophy, by Mr. Heycock, King's College, on Mondays and Wednesdays, at 10 a.m.

Chemistry practically applied to Agriculture, by Mr. Robinson, on Mondays, Wednesdays, and Fridays, at 11 a.m. Begin Jan. 25.

Practical Chemistry, at the University Laboratory, daily. Begin Jan. 25. And at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 21.

EASTER TERM, 1883.

Elementary Chemistry, by a Demonstrator, on Mondays Wednesdays, and Fridays, at 12 noon. Begin April 25.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11. Begin April 24.

Non-Metals (continued) and Organic Chemistry (Elementary), by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 24.

General Principles (continued), by Mr. Pattison Muir, Caius College. Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin April 24.

Gas Analysis, by Mr. Scott, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin April 28.

Catechetical Lectures, by Mr. Lewis, Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin April 25.

Practical Chemistry, at the University Laboratory, daily. Begin April 24. Also at St. John's College. Begin April 16. Also at Caius College. Begin April 23. Also at Sidney College. Begin April 24.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1883-84, are Tuesday, October 2, Tuesday, January 15, and April 22.

Metallurgy.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The following subjects are treated of in the Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the Methods by which Metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The study of the other subjects above referred to, and also of Assaying, is carried on under the direction of the Professor.

Fees.—Lectures only, £3 3s. Practice (including Lectures), for one month, £6 6s.; two, £11 11s.; three, £15 15s.; six, £27 6s.; nine, £37 16s.

Evening Classes.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive, and during the months of April, May, and June. The next Winter Course will begin on Monday, October 8th, and will terminate on Friday, March 28th, 1884, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Thursday Evenings at 6 p.m., beginning October 10th, 1883. Fee, £1 11s. 6d. for the Course, to be paid in advance at the College Office.

UNIVERSITY COLLEGE.

Faculty of Science.

Professor.—Alex. W. Williamson, Ph.D., LLD., F.R.S.

Lecturers.—Henry Forster Morley, M.A., D.Sc.; R. T. Plimpton, Ph.D.; and Temple Orme, F.C.S.

The following classes are included in this department, viz.:—

I. Lectures illustrated by experiments and accompanied by frequent exercises.—General course, exercise course, higher organic courses, matriculation course, course of quantitative analysis.

II. Practical classes in which experiments are performed by the students, and substances examined by them.—Analytical and Research Laboratory, practical class, senior practical class, elementary chemistry (women), summer matriculation course.

General Course.

Lectures on examinations daily, except Saturday, 11 to 12, up to the last week in March.

Fee, for the course, £7 7s.; perpetual, £9 9s.; for the half course, £4 4s.; for the organic course alone, £2 2s.

Students of this class are recommended to attend the exercise class at the same time.

Exercise Class.

Tuesdays and Thursdays at 9, from October till the first week in February. First meeting October 9th.

Fee: £1 11s. 6d.

Matriculation Course.

This course consists of about forty lectures of the general course of chemistry, and about twenty meetings of the exercise class. Students will attend the exercise class throughout the first term, and will receive instructions from time to time from the lecturer as to which meetings of the general course they should attend.

Fee: For forty lectures of the general course, £3 3s.; for the exercise class during the first term, £1 1s.

Practical Chemistry.

Fee: For the course (including cost of materials), £5 5s.; for a second course, £3 3s.

About forty lessons of one hour each, on Tuesday, Wednesday, Thursday, and Friday, from 11 to 12, beginning in the first week in May.

The course includes the practical chemistry required at the Preliminary, Scientific, and Intermediate B.Sc. Examinations of the University of London.

Senior Practical Class.

This course consists of about twenty lectures of two hours each, on Mondays and Saturdays, from 10 to 12.

Fee:—(Including cost of materials), £5 5s.; for a second course, £3 3s.

The course includes the practical chemistry required at the Intermediate M.B. Examination of the University of London.

Students who have matriculated in January and wish to proceed to the Preliminary, Scientific, and Intermediate Science Examinations in the following July, will enter for the Practical Class, and can obtain special instruction in the necessary parts of Theoretical Chemistry, for which purpose they should apply to the Professor of Chemistry

Organic Chemistry.

There are three classes of organic chemistry; in each of them exercises will be given on the subject of each lecture.

The junior class, which forms part of the general course of chemistry, will include the subjects required by candidates for the Intermediate M.B. Pass Examination, and for the diplomas of the College of Physicians and Society of Apothecaries.

The senior class will include the additional subjects required by candidates for Honours in Chemistry at the Int. M.B Examination.

Candidates for the B.Sc. Pass and Honours are advised to enter for the whole course; but if they have previously acquired a general knowledge of the subject they may omit the junior class.

Fees:—For the junior class, £2 2s.; for either senior or higher senior class, £2 12s. 6d.; for two classes, £4 4s.; for the session, £6 6s.; perpetual £9 9s.; perpetual admission to two specified classes, £6 6s.

Summer Matriculation Class (Men).

On Tuesdays, Thursdays, and Fridays, from 9 to 10.

The course includes those parts of chemistry which are required for the Matriculation Examination of the University of London, and is specially adapted for those who have no previous knowledge of the subject. It consists of about 25 lectures and of at least 10 tutorial lessons.

The course includes also 20 lessons in practical chemistry.

The lectures will begin on Friday, March 21st, the practical lessons in the first week in May.

Fee, including cost of materials and apparatus, £5 5s.

Elementary Chemistry (Women).

Lectures:—Wednesday and Friday, from 4 to 5.

A class of elementary chemistry, including the subjects required for Matriculation, will be given during the second and third terms, commencing Wednesday, January 9th.

Fee:—For the course, including the cost of apparatus and materials, £4 4s.

Analytical and Practical Chemistry.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

Quantitative Analysis.

A course of twenty lectures on quantitative analysis will be given during February, March, and April, commencing in the first week of February. Fee, £1 11s. 6d.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1883-84, it is proposed to treat of the following subjects:—

Heating and Lighting.
Metallurgy.
The Chemistry of the Alkali trade.
Chemistry of Brewing.
Agricultural Chemistry.

Fees—for each Course, £2 2s.; for two Courses, £3 3s.; for the five Courses,, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—E. Frankland, Ph.D., D.C.L., F.R.S.
Assistant Professor.—F. R. Japp, M.A., Ph.D.
Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.
Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. Other students are admitted so far as there may be accommodation for them, on the payment of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he select for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the laboratories are £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part II. Lecs. & Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.	Lab.
	£	£	£	£	£
Chemistry	4	13	15	15	
Physics	5	12	12	12	
Biology with Botany	4	8	8	4	8
Geology with Mineralogy ..		4		8	8
Mechanics	4	6	8	8	
Metallurgy	2	13	15		
Assaying for Mining Students		10			
Mining	4	6			
Agriculture	4	10			
Astronomy	2				

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to about £75, and for the remainder of the course for the Associateship they vary from £30 to about £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who have passed in the advanced stage, or in honours, in any subject in the May examination of the Science and Art Department, or in the December examination in Training Colleges, may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from London, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three courses of evening lectures for working men will be given during the session by Professor Goodeve, Dr. Japp, and Mr. Rutley. The admission to each course of six lectures will be 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The following courses of lectures will be delivered during the Session 1883-4, commencing on Sept. 13th.

1. *Inorganic Chemistry.*—A course of experimental lectures on the Non-Metals, Metals, and Theoretical Chemistry, Tuesday, Wednesday, and Friday from 12 to 1. Practical Class on Monday, Wednesday, and Friday from 2 to 5 p.m.

2. *Organic Chemistry.*—A course of experimental lectures on the chief organic compounds, and on the laws which govern their production, decomposition, &c.

3. *Experimental Physics.*—A course of experimental lectures, Tuesday, Wednesday, and Friday from 10 to 11.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—Sydney Young, B.Sc.

DAY LECTURES.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 9 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Special Laboratory Course.

Special instruction will be given on Tuesdays and Thursdays from 4 to 6. The Course is designed for Students entering for elementary examinations in Chemistry, and others to whom the hour may prove convenient.

Fees, £3 3s. for two Terms; £2 2s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 9 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 9 o'clock.

Special Lectures will also be given.

Fee, £3 3s.

Advanced Course.

This Course will be given on Saturdays at 9 o'clock during the first and second Terms, and will be devoted to a more minute consideration of Chemical Theory, as shown in recent researches.

Fee, £2 2s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures, and in Scouring, Bleaching, and Dyeing. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	6 Days a Week.	5 Days a Week.	4 Days a Week.	3 Days a Week.	2 Days a Week.
Per Session	17	15	13	10	7½
,, Two Terms ..	13	11	9	7½	5½
,, One Term ..	7	6	5	4	3
,, Month	3	3	2	2	1½

Students may arrange to divide their days of laboratory work into half-days.

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

EVENING LECTURES.

Inorganic Chemistry.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Chemistry of the Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of the Chemistry of Metals. Special attention will be paid throughout to those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

First and Second Terms.—A Course of Lectures will be delivered on Tuesday evenings at 8 o'clock, on the Scouring, Bleaching, and Dyeing of Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee, 10s. 6d. for two Terms; 7s. for one Term.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

With the approval of the Council of the Institute of Chemistry students desiring to qualify as Associates may pass through the requisite amount of study at this College, which has also been approved as a centre for the Practical Examination of the Institute.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—H. H. Robinson, B.A., and Mr. W. James.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum, They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading

groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and ther substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Assistant Lecturer.—C. H. Bothamley, F.C.S.

The Session begins October 2nd, 1883.

Students of the Leeds School of Medicine are admitted to any of the classes on payment of the class fees, and are not charged with the College entrance fee.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry —Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculation—Wednesday, at 12 noon, during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12, during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 8 p.m., beginning October 10. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 8. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years. Fee, £3 3s.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Goodall Exhibition of £15, tenable for two years.

The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A., B.Sc., Edin.

Demonstrator.—Thomas Turner, F.C.S.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12 o'clock. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommmended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali, Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic Chemistry and Chemical Philosophy* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 10 a.m., commencing Wednesday, October 3rd, 1883. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June (Summer Term). About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 10 a.m. Fee, £2 2s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruc-

tion necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees :—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 „	8½ „
Threee Terms	18 „	12 „

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of about twenty Lectures will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2 o'clock, on the Principles and Practice of Metallurgy. Fee for the Course, £1 1s.

Arrangements will be made in the Chemical Laboratory or giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

Assistant.—H. Ll. Snape.

The Session commences October 1st.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum :—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two or three days a week, during the Lent and Summer Terms ; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry — Second Attendance on General Lecture Course, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable mannner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Laboratory is opened for Students from 10 a.m. to to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained of Adam Holden, 48, Church St., Liverpool, price 6d.

LIVERPOOL COLLEGE OF CHEMISTRY.

Principal.—George Tate, Ph.D., F.G.S., F.C.S.

The Laboratories are open daily from 10 to 5, and also during the winter and spring months, on Tuesday and Wednesday evenings, from 6.30 to 9.30. Evening lectures will be delivered during the winter session by Dr. Tate on Chemistry, Metallurgy, and the Chemistry of Brewing. Arrangements will be made during the session for the members of the classes to visit Chemical and Metallurgical works in the district. Full prospectuses may be had on application.

UNIVERSITY OF DURHAM.

COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator—J. T. Dunn, M.Sc.

The Session will commence on October 1st, 1883.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Mondays, Wednesdays, and Fridays, at 12.5 p.m. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry. Tuesdays and Thursdays, at 11. Fee, £5 5s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular studens must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations :—

1. Durham Senior Examination of Persons not Members of the University, held in June.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises :—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises :—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 22nd of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 1st October.

Two Exhibitions of £15 each will be awarded at the next

examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Watson Smith, F.C.S., Harry Baker, F.C.S., Arthur Smithells, B.Sc., and W. Bott, Ph.D.

The Session begins on October 2, 1883, and ends on June 27, 1884.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior and Tutorial classes. Chemical Laboratory, 2 days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Stratigraphical). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior,* Senior, and Tutorial classes. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* and Tutorial classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures (second course). Physical Laboratory, 1 day per week, or Advanced Mineralogy Lectures and Practical Course. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry Lectures (third and fourth courses). Chemical Laboratory, 4 days per week. Mechanical Drawing, Practical (evening class).

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

Fees.—First year (including College Admission and Library fees), £29 5s.; second year, £27 13s.; third year, £28 10s. 6d.; fourth year, £24 10s.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15. Renewable for a second year.

IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspere Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman, F.C.S.

Lecture Courses.—A systematic course of day lectures is delivered on Tuesday and Friday afternoons at 4.30: the non-metals are treated of in the Autumn Term (1st October to 15th December), the metals in the Spring Term (21st January to 7th April), and the carbon compounds in the Summer Term (21st April to 5th July)

A course of evening lectures runs parallel with the day course, being delivered on Wednesday evenings at 8 o'clock.

A lecture class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Excursions are conducted by the Professor to works where the technical applications of chemistry may be seen by the students.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the Universities of London, Cambridge, or Oxford: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For the day lectures, £2 10s. for the session, and one guinea for a term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Practical Chemistry.—The chemical laboratory is open every day except Saturday from 10 to 1 and from 2.30 to 5.30, also on Monday and Thursday evenings from 6.30 to 9.30. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in Chemical Analysis, and in Experimental and Applied Chemistry. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible; no extra charge is made for the use of gas and water, and of the cheaper chemicals.

Fees.—Inclusive fee £15 per session, or £6 6s. per term; terminal fee for day students for three hours weekly 20s., for six hours 35s., for nine hours 50s., and 10s. extra for each additional three hours per week; for evening students 10s. for one evening per week, and 18s. for two evenings per week.

Pharmaceutical Chemistry.—A course of lectures suited to Students for the Minor Examination of the Pharmaceutical Society is delivered during the Winter and Spring Terms at 8 on Tuesday evenings. Pharmaceutical Students are also admitted to the Chemical Laboratory three hours per week during term time.

Fees.—For lectures and laboratory, 10s. per term to members of the Nottingham Chemists' Association.

Students in the Government Classes.—Lectures and work under the direction of the demonstrator on Monday, Thursday, and Friday evenings.

All classes of Students are eligible to attend without distinction of sex. In virtue of the affiliation of the University College to Cambridge University a suitable course of study is recognised in lieu of part of the ordinary residence at Cambridge. For other information Students are referred to the College Calendar.

UNIVERSITY COLLEGE, DUNDEE.

Professor.—T. Carnelley, D.Sc., F.C.S.

Lecture Assistant.—John Foggie.

The first session of the College will be opened on an early day in October.

The Lectures and Laboratory practice in Chemistry are recognised by the Royal College of Physicians, London, and for degrees in Science and Medicine by the University of Edinburgh.

The courses are suitable for the Degrees of the London University and for the Civil Service appointments, and will also satisfy the requirements of students in Pharmacy, and of students who intend to become candidates for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

Lecture Courses.

The object of these courses will be (1) to give systematic instruction in the general principles of the science, and information regarding the elements and their more important compounds; (2) to show how this knowledge may be usefully applied in the Arts and Manufactures.

A course of instruction in Practical Chemistry in the Laboratory is recommended to all who wish to obtain a sound knowledge of the science, and the methods of applying it to useful purposes—the duration of such course depending upon the special wants of the student.—The Professor will be glad to give any information to intending students.

First year's lecture course: Tuesday, Thursday, and Saturday, from 9 to 10 a.m.; fee, £2 2s.

Second year's lecture course: Monday, Wednesday and Friday, from 9 to 10 a.m.; fee, £2 2s.

Practical Chemistry (Laboratory).

The aim of the Laboratory Courses is to make the student practically acquainted with the science, so that he may conduct chemical analysis and original research, and generally to fit him for applying the science to the Arts, Manufactures, and Agriculture. The courses are also suitable for students preparing for their medical and pharmaceutical examinations. A three months' course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health, may be taken in the College Laboratory.

The Laboratory will be open for students daily from 9 a.m. to 4 p.m., except on Saturdays, when it will be closed at 1 p.m. Each student on entering will be allowed to arrange his working hours to suit his own convenience, but will be required to keep the hours when once fixed.

Sessional Fees for Day Students:—The fees for both sessions are—for six hours per week, £3 3s.; each additional hour per week, 10s. 6d. Day students may not enter for less than six hours a week. Students joining the Laboratory during the second term will be charged two-thirds, and during the third term one-third of the above fees. Students may also enter for short periods, working every day in the week at the following fees:—For one month, £2 12s. 6d.; for two months, £5; for three months, £7 7s.

Evening Classes.—Courses of Lectures and Practical Laboratory instruction.

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 23, 1883.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistant.—James B. M'Arthur.

Junior Assistants.—Thomas Barbour, Robert Anderson, Archibald Kling.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10.15 to 11.15, commencing on Wednesday, Oct. 31st. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals and Organic Chemistry, select chapters. Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturdays also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

Of the several duties which the prestige and traditions of this Chair impose upon its occupant, the first and foremost is to offer to young men, of even limited means, the opportunity of receiving a training in chemistry sufficient to prepare them fully for positions in chemical works, or as professional chemists.

A Special Practical Class for Medical Students, meeting twice a week during the Summer Session.

Evening Lectures, commencing on Friday, Sept. 28th, at 8 p.m.

THE "YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Senior Assistant.—Mr. J. Snodgrass, F.C.S.

Junior Assistant.—Mr. J. Muter.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 5th. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Evening Courses.—There will be special Evening course of twenty-five lectures on each of the following subjects, viz.:—Bleaching, Dyeing, and Printing, by Professor Mills; Iron and Steel Manufacture, and Fuel, by Mr. J. Snodgrass. senior assistant. These lectures will qualify for the May Examinations of the City and Guilds of London Institute. Practical classes in the same subjects will also be formed. For further particulars, see special Prospectuses.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories for Technical Research. Electric Cable has been laid to these laboratories for the supply, if required, of adequate power.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the opinion of the Trustees, unworthy of their position. The

Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 16th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week until the beginning of April, and on two days of each week after May 1st. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry.

II.—*Advanced and Organic Chemistry.*—Lectures on these subjects are given from the beginning of the Session, on Tuesdays and Thursdays, at 10 a.m., until the beginning of April, and on the same days at 3 p.m., after May 1st.

III.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

IV.—*Laboratory Pupils.*—The Chemical Laboratory is open from November until the beginning of April, and from May 1st until the middle of July, on the first five days of the week, from 10 a.m. until 4 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £5 for the first period, or of £3 10s. for the second period (or for a single term).

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 16th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

UNIVERSITY OF DUBLIN.

Trinity College.

Professor of Chemistry.—J. Emerson Reynolds, M.D., F.R.S.

Senior Assistant and Demonstrator.—William Early, F.I.C.

The professor of chemistry lectures on Elementary Chemistry during the whole of Michaelmas and Hilary Terms, on the Non-Metals and Metals; and the students repeat in the Laboratories many of the experiments shown at lecture.

The advanced course consists chiefly of Laboratory instruction in qualitative analysis (including spectrum analysis) commencing in Michaelmas Term, about November 1st. Volumetric and gravimetric analysis, commencing in Hilary Term. Organic preparations and analysis, commencing in Trinity Term.

Professor Reynolds lectures on Organic Chemistry during Trinity Term. In the main Laboratory facilitates are afforded for the prosecution of experimental researches.

ROYAL COLLEGE OF SCIENCE FOR IRELAND,

Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 1, 1883.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each. with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City and Guilds of London Institute for the Advancement of Technical Education, Tabernacle Row, E.C.—Session commences October 4, 1883. Day and Evening Lectures and Laboratory instruction.

City of London College, 52, Leadenhall Street, E.C.—Chemical Lecturer—Mr. J. Howard, F.C.S. The courses of lectures are as follows:—

Elementary Electricity .. .. .. Wednesdays, 8—9.
Elementary Chemistry .. .. .. Mondays, 7—8.

The Session will commence on Monday, October 1. Fee, 7s. 6d. per course.

These classes are specially arranged for Students preparing for the Science and Art Department Examinations, Matriculation, Chemists' Assistants, Teachers, &c.

Crystal Palace Company's School of Art, Science, and Literature. School of Practical Engineering. *Principal*—Mr. J. W. Wilson, Memb. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best

to utilise the means at their disposal, especially when entirely dependent on their own resources.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, Literature, &c., so that education of the highest class might be afforded under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1883-84:—Cambridge Local, December, 1883; Oxford Local and Oxford Examination for Women, June, 1884; Cambridge Higher Examination, June, 1884. The session opens on October 1.

Charterhouse Institution.—The Session commences September 22, under the presidency of the Rev. Henry Swann, M.A, Lectures and Practical Work in a well-fitted laboratory capable of holding 60 students.

Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane. — Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.15 to 9.15; Advanced, Tuesdays, 9.15 to 10.15. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 2nd. Practical Chemistry:—This Class will meet in the Laboratory of the Institution, under the direction of Messrs. G. Chaloner and H. Chapman Jones, on Saturdays (Inorganic) from 4 to 6, and (Organic) from 8 to 10 p.m. A course of about thirty Lectures on the Manufacture of Iron and Steel, by Mr. G. Chaloner, on Saturdays at 7, commencing October 6.

Berners College of Chemistry and the Experimental Sciences, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year. A practical School of Science of a private character; the Courses of study are carried on by private class lectures in the various subjects, and by private Courses of study. These Courses are limited as to time, but are continued so long as is necessary to the Complete practical study of the subject or subjects by the Pupil or Pupils. The studies embrace the Experimental Sciences and Chemistry—Agricultural, Technical, and Analytical; the Science and Practice of Photography, Steam, Telegraphy, Electricity, Magnetism, and Galvanism, the Natural Sciences of Mineralogy, Geology, and Botany. The preparation of Gentlemen for the various Examining Boards and investigations connected with Patents are prominent features of the work of this College. Evening Classes.

New Central School of Chemistry and Pharmacy, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction Classes are held for Students of Medicine.

South London School of Chemistry, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

St. John's Training College, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College. Lecturer and Director of the Laboratory, Alfred Senier, M.D., F.I.C., F.C.S.

The Westminster College of Chemistry and Pharmacy, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 9 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session.				Summer Session.			
	Lecturers on Chemistry.	Days and Hours.	Fees.		Lecturers on Chemistry.	Days and Hours.	Fees.	
			One Course.	Perpetual.			One Course.	Perpetual.
			£ s.	£ s.			£ s.	£ s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6 16/6	9 9	Dr. Russell	M. Tu. F., [to 1] 11	3 3	3 3
Charing Cross Hospital and College	Mr. Heaton	M. W. F., 4	5 5		Mr. Heaton	Daily at 10	4 4	
St. George's Hospital ..	Mr. Donkin	Tu. Th. S., 11½	7 7	8 18	Mr. Donkin	M. W. F., 10 to 1	7 7	
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7		Mr. Groves			
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10½	8 8	11 11	Mr. Bloxam and Mr. Thomson & Mr. Johnson	M. W. Th., 10½	6 6	8 8
London Hospital	Dr. Tidy	M. W. F., 10.30	7 7	10 10	Dr. Tidy	Daily at 9	5 5	
St. Mary's Hospital ..	Dr. Wright	M. Th. 10, W. S., 9	6 16/6		Dr. Wright	W. F. S., 9	4 4	
Middlesex Hospital ..	Mr. W. Foster	M W. Th. Fr., 3	8 8		Mr. W. Foster	M. W. F., 3	4 4	
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th. F., 10½	7 7	10 10	Dr. Bernays	M. Th. F., 10	6 6	
University Col. & Hosp.	Dr. Williamson, F.R.S.,	Daily (ex. S.), 11	7 7	9 9	Dr. Williamson	Dy. (ex. M. S.), 11	5 5	
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	7 6	8 8	Dr. A. Dupré	M. W. F., 10	4 4	

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Monday, the 1st of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, assisted by Mr. Wyndham R. Dunstan, F.C.S., on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, assisted by Mr. Wyndham R. Dunstan and Mr. F. W. Short, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirement of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class

for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Lectures and Laboratory instruction in Chemistry and Pharmacy. Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Metallurgical Laboratories are open every day and evening for practical work. Principal, Mr. W. H. Martin.

Institute of Agriculture, South Kensington.—Established for the purpose of advancing Technical Instruction upon various sections of Agricultural Practice, as a preparation for learning the business of farming, and especially for bringing these advantages within the reach of any and every person who may wish to avoid the expenses which are at preseat associated with education of this character. In the Lecture Theatre of the Museum of Geology, Jermyn-street, London: A course of forty lectures upon Chemistry in relation to the Soil, by Bernard Dyer, F.C S., F.I.C., commencing Oct. 1st. In the Lecture Theatre of South Kensington Museum: A course of ten lectures upon the Chemistry of the Food of Farm Stock, by Professor R. V. Tuson, F.I.C., commencing Jan. 21st, 1884.

Birmingham.—Queen's College.—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

Institute of Chemical Technology, Hackins Hey, Liverpool.—Principal, Mr. A. Norman Tate, F.I.C. The course of instruction is intended more especially for students who wish to gain a knowledge of chemistry and the allied sciences in their relation to industrial and commercial pursuits, and embraces a thorough preliminary course of theoretical chemistry and practical laboratory work, followed by instruction in chemical technology fitted to the requirements of each pupil. In addition to these chemical studies, students who desire it can enter upon a special course calculated to afford them knowledge useful in the erection and arrangement of manufactories and plant, and construction of apparatus. Fee: Fifty guineas per annum, with extra fee according to circumstances for the special course.

Leeds School of Medicine.—Prof. T. E. Thorpe, Ph.D., F.R.S.

Queenwood College, near Stockbridge, Hants.—Dr. H. Wilson Hake, F.C.S., F.I.C. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction. Principal, Mr. C. Willmore.

Salford Working Men's College, Evening Classes.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

Sheffield School of Medicine.—Mr. A. H. Allen, F.C.S.

Sheffield Borough Analysts' Laboratory, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

Wesley College, Sheffield.—Lectures on Physics, by Mr. A. H. Allen, F.C.S.; Chemistry, with daily demonstrations and laboratory practice, by Mr. R. W. Lancaster; Biology, with lectures and laboratory practice, by the Principal, the Rev. W. H. Dallinger, F.R.S., commencing September 20.

University of Aberdeen.—Mr. J. S. Brazier, F.C.S.

Dundee Literary Institution Chemical and Physical Laboratory.—Lecturers on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson. Classes and Evening Lectures daily.

School of Medicine, Surgeon's Hall, Edinburgh.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, Mr. Drinkwater, and Mr. Buchanan.

School of Pharmacy and Chemistry, Edinburgh.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Day and Evening Classes.

Edinburgh School of Medicine, 41, Chambers St.—The instruction here qualifies for all Medical Boards, Edinburgh University, London University, &c. Day and Evening Classes.

Minto House Medical School, Chambers Street, Edinburgh.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

New Veterinary College, Gayfield House, Edinburgh.—Dr. Stevenson Macadam and Mr. Falconer King, F.C.S.

Science Schools, Falkirk.—Andrew Wilson and Assistants. Day and Evening Classes in Theoretical and Practical Chemistry.

Glasgow University.—Prof. J. Ferguson.

Glasgow Veterinary College.—Professor Cooke, F.C.S.

College of Science and Arts, Glasgow.—Mr. R. R. Tatlock, F.C.S., and Dr. Clark, F.C.S. Day and Evening Classes.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

Chemical Laboratory, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

Queen's College, Galway.—Dr. T. H. Rowney.

Munster Agricultural and Dairy School.—Thomas Farrington, M.A., F.C.S.

Royal College of Surgeons in Ireland.—Dr. C. A. Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

Dublin, Carmichael College of Medicine.—Dr. C. R. C. Tichborne.

Dublin, Catholic University.—Dr. Campbell.

Dublin, Dr. Steevens's Hospital and Medical College.—Mr. McHugh.

Mechanics' Institute, Abbey Street, Dublin.—Mr. Clement J. Leaper.

Detection of Traces of Bismuth.—J. C. Tresh.—If potassium iodide is added to a small quantity of a free acid,—hydrochloric or an organic acid,—there appears in presence of bismuth a more or less intense orange colour. If the metal is 1-10,000th, the colour is a decided orange; if 1-40,000th, a pale orange; and 1-1,000,000th, yellow. Lead and mercury do not interfere.—*Zeitschrift für Analytische Chemie.*

THE YORKSHIRE COLLEGE, LEEDS.

The Tenth Session begins on the 2nd October.

Chemistry: Prof. THORPE, Ph.D., F.R.S., F.C.S.
Dyeing: Instructor J. HUMMEL, F.C.S.

Lectures and Practical Work in Laboratories and Dyehouse.

Classes in the Science, Literature, and Technological Departments prepare for University, and other examinations, and for various professions.

Prospectus of any Department may be had free on application to the Secretary.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES, South Kensington.

Dean, Professor HUXLEY, P.R.S.

SESSION 1883-4.

BIOLOGY—Professor Huxley will begin a course of lectures on 1st October.

CHEMISTRY—Professor Frankland will begin a course of lectures on 1st October.

PHYSICS—Professor Guthrie will begin a course of lectures on 3rd October.

METALLURGY—Professor Chandler Roberts will begin a course of lectures on 1st October.

AGRICULTURE—Mr. Wrightson will begin a course of lectures on 1st October.

Further particulars may be obtained from the Registrar.

CITY AND GUILDS OF LONDON INSTITUTE.

TECHNICAL COLLEGE, FINSBURY.

EVENING DEPARTMENT for Apprentices, Journeymen, Foremen, and others. Instruction in Mechanical and Electrical Engineering, Technical Chemistry, Applied Art, Cabinet-making, Metal Plate Work, Plumbers' Work, Carpentry, Joinery, Bricklaying, &c. Fees, from 7s. to 30s. for the Session, inclusive of laboratories and workshops.

The NEW SESSION COMMENCES on October 4, 1883.

For programme of instruction apply at the College, Tabernacle Row, E.C.; or at the Offices of the Institute, Gresham College, E.C.

CITY AND GUILDS OF LONDON INSTITUTE.

TECHNOLOGICAL EXAMINATIONS.—The next Examination will be held on May 28th, 1884. Teachers desiring to form classes should apply at once to the Director, at the Office of the Institute, Gresham College, London, E.C.

The programme for 1883-4 is now ready.

PHILIP MAGNUS, Director and Secretary.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.

—The SESSION 1883-4 will commence on Monday, October 1st, 1883. The Prizes for the past Session, and the Nursing Probationers' Prizes, will be distributed on Tuesday, October 9th, at 8 p.m., by Professor Huxley, P.R.S., who will also make an Address, after which there will be a Conversazione, to which all past and present students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital appointments are free. The resident appointments consist of Five House Physiciancies, Five House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

MUNRO SCOTT, Warden.

UNIVERSITY COLLEGE, DUNDEE.

The FIRST SESSION will begin on MONDAY, 8th OCTOBER. CLASSES will meet in the following Departments:—

Mathematics and Natural Philosophy	Prof. J. E. A. STEGGALL, M.A. Demonstrator—J. W. CAPSTICK, B.A., B.Sc.
Chemistry	Prof. THOMAS CARNELLEY, D.Sc., B.Sc., F.C.S.
Engineering and Drawing	Prof. J. A. EWING, B.Sc., F.R.S.E.
Classics and Ancient History	Prof. W. PETERSON, M.A.
English Language and Literature and Modern History	Prof. THOMAS GILRAY, M.A., F.R.S.E.

The PHYSICAL, CHEMICAL, ENGINEERING, and ELECTRICAL ENGINEERING LABORATORIES are furnished with every appliance for study and research.

There are DAY and EVENING CLASSES, all of which are open to Women.

The various Courses are suitable for the Degree Examinations of the University of London, and for the Examination for the L.L.A. Certificate in St. Andrews University.

The Examination for the SMART BURSARY in ENGINEERING will be held on the 3rd and 4th October.

For further information see the College Calendar.

SHIELL and SMALL, Secretaries.

LIVERPOOL COLLEGE of CHEMISTRY, DUKE STREET.

PRINCIPAL—GEORGE TATE, Ph.D., F.G.S., F.C.S.

Prospectuses of the Courses may be had on application.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

SCIENTIFIC AND TECHNICAL EDUCATION. SESSION 1883-84.

This College supplies a complete course of Instruction in Science as applied to the Industrial Arts, especially those which may be classed broadly under the heads of CHEMICAL MANUFACTURES, MINING, and ENGINEERING.

A Diploma of Associate of the College is granted at the end of the Three Years' Course.

There are Four Royal Scholarships, tenable for two years, each of the value of £50 yearly, with free education, including Laboratory Instruction. Two become vacant each year. They are given to Students who have been a year in the College.

The Fees are £2 for each Course, or £10 for all the Courses of each year, with the exception of Laboratory Practice.

Chemistry (Theoretical and Practical), Metallurgy, &c.	Professor HARTLEY, F.C.S., F.R.S.E.
Mathematics, Mechanics, and Mechanism	Professor HENNESSY, F.R.S., M.R.I.A.
Descriptive Geometry, Drawing, Engineering, and Surveying	Professor PIGOT, C.E., M.R.I.A., Dean of Faculty.
Experimental Physics (Theoretical and Practical)	Professor BARRETT, F.R.S.E., M.R.I.A.
Mining and Mineralogy	Prof. O'REILLY, C.E., M.R.I.A.
Botany	Professor M'NAB, M.D., F.L.S.
Zoology	Professor HADDON, M.A., F.Z.S.
Geology	Prof. HULL, M.A., LL.D., F.R.S.
Palæontology	Mr. BAILY, F.L.S., F.G.S., M.R.I.A.

The Chemical and Physical Laboratories and Drawing School are open daily for Practical Instruction.

Fee for Chemical Laboratory, £2 for One month, £5 for Three months, £9 for Six months, or £12 for Session. Fee for Physical Laboratory, £1 per month, or £6 for Session. Fee for Special Course of applied Electricity and Laboratory, £4. Fee for Biological Laboratory, £2 for the term. Fee for Drawing School, £3 for Session, or £2 for one term.

The SESSION COMMENCES on MONDAY, OCTOBER 1st.

Programmes may be obtained on application at the College, or by letter addressed to the Secretary, Royal College of Science, Stephen's Green, Dublin.

Professor J. P. O'REILLY, Secretary, *pro tem.*

INSTITUTE OF CHEMICAL TECHNOLOGY AND ANALYTICAL LABORATORY,

5, 9, and 11, PHILADELPHIA CHAMBERS, HACKINS HEY, and 3 and 12A, ASHTON CHAMBERS, HACKINS HEY, LIVERPOOL.

PRINCIPAL—A. NORMAN TATE, F.I.C.

Designed for the examination, for scientific, commercial, and industrial purposes, of substances used and produced in the Arts and Manufactures, and found in Commerce; and for the instruction of Students in Chemistry and the allied sciences in their relation to industrial and commercial pursuits.

The Laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and Student's work.

Students' fees, fifty guineas per annum.

In addition to their chemical studies, Students who desire it can enter upon a course of instruction calculated to afford them knowledge useful in the erection and arrangement of manufacturing buildings and plant, and construction of apparatus. Special fees are charged for this course.

All communications should be addressed to Mr. A. NORMAN TATE, 9, Hackins Hey, Liverpool, as, owing to similarity of surname with that of the principal of another chemical establishment in Liverpool, misconception and mistakes have arisen.

UNIVERSITY COLLEGE, BRISTOL. CHEMICAL DEPARTMENT.

Professor—W. RAMSAY, Ph.D. Lecturer—SYDNEY YOUNG, D.Sc

The SESSION 1883-84 begins on 8th OCTOBER. Lectures on Inorganic, Organic, and Technical Chemistry will be delivered during the Session. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. In the evening, Lectures on Inorganic Chemistry at reduced fees are delivered; and a special Course of Lectures on Technical Chemistry is also given, with the co-operation of the Worshipful Company of Clothworkers. Several Scholarships are tenable at the College.

Calendar, containing full information, price 6d., by post 8d. For prospectus and further information apply to

ALFRED E. STOCK, Registrar and Secretary.

THE CHEMICAL NEWS.

Vol. XLVIII. No. 1243.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Southport Meeting, September 19, 1883.

INAUGURAL ADDRESS OF THE PRESIDENT,

Arthur Cayley, M.A., D.C.L., LL.D., F.R.S., Sadlerian Professor of Pure Mathematics in the University of Cambridge.

Since our last meeting we have been deprived of three of our most distinguished members. The loss by the death of Professor Henry John Stephen Smith is a very grievous one to those who knew and admired and loved him, to his University, and to mathematical science, which he cultivated with such ardour and success. I need hardly recall that the branch of mathematics to which he had specially devoted himself was that most interesting and difficult one, the Theory of Numbers. The immense range of this subject, connected with and ramifying into so many others, is nowhere so well seen as in the series of reports on the progress thereof, brought up unfortunately only to the year 1865, contributed by him to the Reports of the Association; but it will still better appear when to these are united (as will be done in the collected works in course of publication by the Clarendon Press) his other mathematical writings, many of them containing his own further developments of theories referred to in the reports. There have been recently or are being published many such collected editions—Abel, Cauchy, Clifford, Gauss, Green, Jacobi, Lagrange, Maxwell, Riemann, Steiner. Among these the works of Henry Smith will occupy a worthy position.

More recently, General Sir Edward Sabine, K.C.B., for twenty-one years general secretary of the Association, and a trustee, President of the meeting at Belfast in the year 1852, and for many years treasurer and afterwards President of the Royal Society, has been taken from us, at an age exceeding the ordinary age of man. Born October, 1788, he entered the Royal Artillery in 1803, and commanded batteries at the siege of Fort Erie in 1814; made magnetic and other observations in Ross and Parry's North Polar exploration in 1818-19, and in a series of other voyages. He contributed to the Association reports on Magnetic Forces in 1836-7-8, and about forty papers to the *Philosophical Transactions*; originated the system of Magnetic Observatories, and otherwise signally promoted the science of Terrestrial Magnetism.

There is yet a very great loss: another late President and trustee of the Association, one who has done for it so much, and has so often attended the meetings, whose presence among us at this meeting we might have hoped for—the President of the Royal Society, William Spottiswoode. It is unnecessary to say anything of his various merits: the place of his burial, the crowd of sorrowing friends who were present in the Abbey, bear witness to the esteem in which he was held.

I take the opportunity of mentioning the completion of a work promoted by the Association: the determination by Mr. James Glaisher of the least factors of the missing three out of the first nine million numbers: the volume containing the sixth million is now published.

I wish to speak to you to-night upon Mathematics. I am quite aware of the difficulty arising from the abstract nature of my subject; and if, as I fear, many or some of you, recalling the Presidential Addresses at former meetings—for instance, the *résumé* and survey which we had at York of the progress, during the half-century of the lifetime of the Association, of a whole circle of sciences—Biology, Palæontology, Geology, Astronomy, Chemistry—so much more familiar to you, and in which there was so much to tell of the fairy-tales of science; or at Southampton, the discourse of my friend who has in such kind terms introduced me to you, on the wondrous practical applications of science to electric lighting, telegraphy, the St. Gothard Tunnel and the Suez Canal, gun-cotton, and a host of other purposes, and with the grand concluding speculation on the conservation of solar energy: if, I say, recalling these or any earlier Addresses, you should wish that you were now about to have, from a different President, a discourse on a different subject, I can very well sympathise with you in the feeling.

But be this as it may, I think it is more respectful to you that I should speak to you upon and do my best to interest you in the subject which has occupied me, and in which I am myself most interested. And in another point of view, I think it is right that the Address of a President should be on his own subject, and that different subjects should be thus brought in turn before the meetings. So much the worse, it may be, for a particular meeting; but the meeting is the individual, which on evolution principles must be sacrificed for the development of the race.

Mathematics connect themselves on the one side with common life and the physical sciences; on the other side with philosophy, in regard to our notions of space and time, and in the questions which have arisen as to the universality and necessity of the truths of mathematics, and the foundation of our knowledge of them. I would remark here that the connection (if it exists) of arithmetic and algebra with the notion of time is far less obvious than that of geometry with the notion of space.

As to the former side, I am not making before you a defence of mathematics, but if I were I should desire to do it—in such manner as in the "Republic" Socrates was required to defend justice, quite irrespectively of the worldly advantages which may accompany a life of virtue and justice, and to show that, independently of all these, justice was a thing desirable in itself and for its own sake—*not* by speaking to you of the utility of mathematics in any of the questions of common life or of physical science. Still less would I speak of this utility before, I trust, a friendly audience, interested or willing to appreciate an interest in mathematics in itself and for its own sake. I would, on the contrary, rather consider the obligations of mathematics to these different subjects as the sources of mathematical theories now as remote from them, and in as different a region of thought—for instance, geometry from the measurement of land, or the Theory of Numbers from arithmetic—as a river at its mouth is from its mountain source.

On the other side, the general opinion has been and is that it is indeed by experience that we arrive at the truths of mathematics, but that experience is not their proper foundation: the mind itself contributes something. This is involved in the Platonic theory of reminiscence; looking at two things, trees or stones or anything else, which seem to us more or less equal, we arrive at the idea of equality: but we must have had this idea of equality before the time when first seeing the two things we were led to regard them as coming up more or less perfectly to this idea of equality; and the like as regards our idea of the beautiful, and in other cases.

The same view is expressed in the answer of Leibnitz, the *nisi intellectus ipse*, to the scholastic dictum, *nihil in intellectu quod non prius in sensu*: there is nothing in the intellect which was not first in sensation, except (said Leibnitz) the intellect itself. And so again in the "Critick of Pure Reason," Kant's view is that while there is no doubt but that all our cognition begins with experience,

we are nevertheless in possession of cognitions *a priori*, independent, not of this or that experience, but absolutely so of all experience, and in particular that the axioms of mathematics furnish an example of such cognitions *a priori*. Kant holds further that space is no empirical conception which has been derived from external experiences, but that in order that sensations may be referred to something external, the representation of space must already lie at the foundation; and that the external experience is itself first only possible by this representation of space. And in like manner time is no empirical conception which can be deduced from an experience, but it is a necessary representation lying at the foundation of all intuitions.

And so in regard to mathematics, Sir W. R. Hamilton, in an Introductory Lecture on astronomy (1836), observes: "These purely mathematical sciences of algebra and geometry are sciences of the pure reason, deriving no weight and no assistance from experiment, and isolated or at least isolable from all outward and accidental phenomena. The idea of order with its subordinate ideas of number and figure, we must not indeed call innate ideas, if that phrase be defined to imply that all men must possess them with equal clearness and fulness: they are, however, ideas which seem to be so far born with us that the possession of them in any conceivable degree is only the development of our original powers, the unfolding of our proper humanity."

The general question of the ideas of space and time, the axioms and definitions of geometry, the axioms relating to number, and the nature of mathematical reasoning, are fully and ably discussed in Whewell's "Philosophy of the Inductive Sciences" (1840), which may be regarded as containing an exposition of the whole theory.

But it is maintained by John Stuart Mill that the truths of mathematics, in particular those of geometry, rest on experience; and as regards geometry, the same view is on very different grounds maintained by the mathematician Riemann.

It is not so easy as at first sight it appears to make out how far the views taken by Mill in his "System of Logic Ratiocinative and Inductive" (9th ed., 1879), are absolutely contradictory to those which have been spoken of; they profess to be so; there are most definite assertions (supported by argument), for instance, p. 263:—"It remains to enquire what is the ground of our belief in axioms, what is the evidence on which they rest. I answer, they are experimental truths, generalisations from experience. The proposition, 'Two straight lines cannot enclose a space,' or, in other words, two straight lines which have once met cannot meet again, is an induction from the evidence of our senses." But I cannot help considering a previous argument (p. 259) as very materially modifying this absolute contradiction. After enquiring "Why are mathematics by almost all philosophers . . . considered to be independent of the evidence of experience and observation, and characterised as systems of necessary truth?" Mill proceeds (I quote the whole passage) as follows:—"The answer I conceive to be that this character of necessity ascribed to the truths of mathematics, and even (with some reservations to be hereafter made) the peculiar certainty ascribed to them, is a delusion, in order to sustain which it is necessary to suppose that those truths relate to and express the properties of purely imaginary objects. It is acknowledged that the conclusions of geometry are derived partly at least from the so-called definitions, and that these definitions are assumed to be correct representations, as far as they go, of the objects with which geometry is conversant. Now we have pointed out that from a definition as such no proposition unless it be one concerning the meaning of a word can ever follow, and that what apparently follows from a definition follows in reality from an implied assumption that there exists a real thing conformable thereto. This assumption in the case of the definitions of geometry is not strictly true: there exist no real things exactly conformable to the definitions. There exist no real points without magnitude, no lines without breadth, nor perfectly straight, no circles with all their radii exactly equal, nor squares with all their angles perfectly right. It will be said that the assumption does not extend to the actual but only to the possible existence of such things. I answer that according to every test we have of possibility they are not even possible. Their existence, so far as we can form any judgment, would seem to be inconsistent with the physical constitution of our planet at least, if not of the universal [*sic*]. To get rid of this difficulty and at the same time to save the credit of the supposed system of necessary truth, it is customary to say that the points, lines, circles, and squares which are the subjects of geometry exist in our conceptions merely and are parts of our minds; which minds by working on their own materials construct an *a priori* science, the evidence of which is purely mental and has nothing to do with outward experience. By howsoever high authority this doctrine has been sanctioned, it appears to me psychologically incorrect. The points, lines, and squares which anyone has in his mind are (as I apprehend) simply copies of the points, lines, and squares which he has known in his experience. Our idea of a point I apprehend to be simply our idea of the *minimum visibile*, the small portion of surface which we can see. We can reason about a line as if it had no breadth, because we have a power which we can exercise over the operations of our minds: the power, when a perception is present to our senses or a conception to our intellects, of *attending* to a part only of that perception or conception instead of the whole. But we cannot *conceive* a line without breadth: we can form no mental picture of such a line; all the lines which we have in our mind are lines possessing breadth. If anyone doubt this, we may refer him to his own experience. I much question if anyone who fancies that he can conceive of a mathematical line thinks so from the evidence of his own consciousness. I suspect it is rather because he supposes that unless such a perception be possible, mathematics could not exist as a science: a supposition which there will be no difficulty in showing to be groundless."

I think it may be at once conceded that the truths of geometry are truths precisely because they relate to and express the properties of what Mill calls "purely imaginary objects;' that these objects do not exist in Mill's sense, that they do not exist in nature, may also be granted; that they are "not even possible," if this means not possible in an existing nature, may also be granted. That we cannot "conceive" them depends on the meaning which we attach to the word conceive. I would myself say that the purely imaginary objects are the only realities, the *ὄντως ὄντα*, in regard to which the corresponding physical objects are as the shadows in the cave; and it is only by means of them that we are able to deny the existence of a corresponding physical object; if there is no conception of straightness, then it is meaningless to deny the existence of a perfectly straight line.

But at any rate the rate the objects of geometrical truth are the so-called imaginary objects of Mill, and the truths of geometry are only true, and *a fortiori* are only necessarily true, in regard to these so-called imaginary objects; and these objects, points, lines, circles, &c., in the mathematical sense of the terms, have a likeness to and are represented more or less imperfectly, and from a geometer's point of view no matter how imperfectly, by corresponding physical points, lines, circles, &c. I shall have to return to geometry, and will then speak of Riemann, but I will first refer to another passage of the Logic.

Speaking of the truths of arithmetic Mill says (p. 297) that even here there is one hypothetical element: "In all propositions concerning numbers a condition is implied without which none of them would be true, and that condition is an assumption which may be false. The condition is that 1=1: that all the numbers are numbers of the same or of equal units." Here at least the assumption

may be absolutely true; one shilling=one shilling in purchasing power, although they may not be absolutely of the same weight and fineness: but it is hardly necessary; one coin + one coin = two coins, even if the one be a shilling and the other a half crown. In fact, whatever difficulty be raisable as to geometry, it seems to me that no similar difficulty applies to arithmetic; mathematician or not, we have each of us, in its most abstract form, the idea of a number; we can each of us appreciate the truth of a proposition in regard to numbers; and we cannot but see that a truth in regard to numbers is something different in kind from an experimental truth generalised from experience. Compare, for instance, the proposition that the sun, having already risen so many times, will rise to-morrow, and the next day, and the day after that, and so on; and the proposition that even and odd numbers succeed each other alternately *ad infinitum*: the latter at least seems to have the characters of universality and necessity. Or again, suppose a proposition observed to hold good for a long series of numbers, one thousand numbers, two thousand numbers, as the case may be; this is not only no proof, but it is absolutely no evidence, that the proposition is a true proposition, holding good for all numbers whatever; there are in the Theory of Numbers very remarkable instances of propositions observed to hold good for very long series of numbers and which are nevertheless untrue.

I pass in review certain mathematical theories.

In arithmetic and algebra, or say in analysis, the numbers or magnitudes which we represent by symbols are in the first instance ordinary (that is, positive) numbers or magnitudes. We have also in analysis and in analytical geometry *negative* magnitudes; there has been in regard to these plenty of philosophical discussion, and I might refer to Kant's paper, "Ueber die negativen Grössen in die Weltweisheit" (1763), but the notion of a negative magnitude has become quite a familiar one, and has extended itself into common phraseology. I may remark that it is used in a very refined manner in bookkeeping by double entry.

But it is far otherwise with the notion which is really the fundamental one (and I cannot too stronly emphasise the assertion) underlying and pervading the whole of modern analysis and geometry, that of imaginary magnitude in analysis and of imaginary space (or space as a *locus in quo* of imaginary points and figures) in geometry: I use in each case the word imaginary as including real. This has not been, so far as I am aware, a subject of philosophical discussion or enquiry. As regards the older metaphysical writers this would be qute accounted for by saying that they knew nothing, and were not bound to know anything about it; but at present, and, considering the prominent position which the notion occupies—say even that the conclusion were that the notion belongs to mere technical mathematics, or has reference to nonenties in regard to which no science is possible, still it seems to me that (as a subject of philosophical discussion) the notion ought not to be thus ignored; it should at least be shown that there is a right to ignore it.

Although in logical order I should perhaps now speak of the notion just referred to, it will be convenient to speak first of some other quasi-geometrical notions; those of more-than-three-dimensional space, and of non-Euclidian two- and three-dimensional space, and also of the generalised notion of distance. It is in connection with these that Riemann considered that our notion of space is founded on experience, or rather that it is only by experience that we know that our space is Euclidian space.

It is well known that Euclid's twelfth axiom, even in Playfair's form of it, has been considered as needing demonstration; and that Lobatschewsky constructed a perfectly consistent theory, wherein this axiom was assumed not to hold good, or say a system of non-Euclidian plane geometry. There is a like system of non-Euclidian solid geometry. My own view is that Euclid's twelfth axiom in Playfair's form of it does not need demonstration, but is part of our notion of space, of the physical space of our experience—the space, that is, which we become acquainted with by experience, but which is the representation lying at the foundation of all external experience. Riemann's view before referred to may I think be said to be that, having *in intellectu* a more general notion of space (in fact a notion of non-Euclidian space), we learn by experience that space (the physical space of our experience) is, if not exactly, at least to the highest degree of approximation, Euclidian space.

But suppose the physical space of our experience to be thus only approximately Euclidian space, what is the consequence which follows? *Not* that the propositions of geometry are only approximately true, but that they remain absolutely true in regard to that Euclidian space which has been so long regarded as being the physical space of our experience.

It is interesting to consider to different ways in which, without any modification at all of our notion of space, we can arrive at a system of non-Euclidian (plane or two-dimensional) geometry; and the doing so, will, I think, throw some light on the whole question.

First, imagine the earth a perfectly smooth sphere; understand by a plane the surface of the earth, and by a line the apparently straight line (in fact an arc of great circle) drawn on the surface; what experience would in the first instance teach would be Euclidian geometry; there would be intersecting lines which produced a few miles or so would seem to go on diverging: and apparently parallel lines which would exhibit no tendency to approach each other; and the inhabitants might very well conceive that they had by experience established the axiom that two straight lines cannot enclose a space, and the axiom as to parallel lines. A more extended experience and more accurate measurements would teach them that the axioms were each of them false; and that any two lines, if produced far enough each way, would meet in two points: they would in fact arrive at a spherical geometry, accurately representing the properties of the two-dimensional space of their experience. But their original Euclidian geometry would not the less be a true system: only it would apply to an ideal space, not the space of their experience.

Secondly, consider an ordinary, indefinitely extended plane; and let us modify only the notion of distance. We measure distance, say, by a yard measure or a foot rule, anything which is short enough to make the fractions of it of no consequence (in mathematical language by an infinitesimal element of length); imagine, then, the length of this rule constantly changing (as it might do by an alteration of temperature), but under the condition that its actual length shall depend only on its situation on the plane and on its direction: viz., if for a given situation and direction it has a certain length, then whenever it comes back to the same situation and direction it must have the same length. The distance along a given straight or curved line between any two points could then be measured in the ordinary manner with this rule, and would have a perfectly determinate value: it could be measured over and over again, and would always be the same; but of course it would be the distance, not in the ordinary acceptation of the term, but in quite a different acceptation. Or in somewhat different way: if the rate of progress from a given point in a given direction be conceived as depending only on the configuration of the ground, and the distance along a given path between any two points thereof be measured by the time required by traversing it, then in this way also the distance would have a perfectly determine value; but it would be a distance, not in the ordinary acceptation of the term, but in quite a different acceptation. And corresponding to the new notion of distance we should have a new, non-Euclidian system of plane geometry; all theorems involving the notion of distance would be altered.

We may proceed further. Suppose that as the rule moves away from a fixed central point of the plane it becomes shorter and shorter; if this shortening takes place with sufficient rapidity, it may very well be that a distance which in the ordinary sense of the word is finite will in the new sense be infinite; no number of repetitions of the length of the ever-shortening rule will be sufficient to cover it. There will be surrounding the central point a certain finite area such that (in the new acceptation of the term distance) each point of the boundary thereof will be at an infinite distance from the central point; the points outside this area you cannot by any means arrive at with your rule; they will form a *terra incognita*, or rather an unknowable land: in mathematical language, an imaginary or impossible space: and the plane space of the theory will be that within the finite area—that is, it will be finite instead of infinite.

We thus with a proper law of shortening arrive at a system of non-Euclidian geometry which is essentially that of Lobatschewsky. But in so obtaining it we put out of sight its relation to spherical geometry: the three geometries (spherical, Euclidian, and Lobatschewsky's) should be regarded as members of a system; viz., they are the geometries of a plane (two-dimensional) space of constant positive curvature, zero curvature, and constant negative curvature respectively; or again, they are the plane geometries corresponding to three different notions of distance; in this point of view they are Klein's elliptic, parabolic, and hyperbolic geometries respectively.

Next as regards solid geometry: we can by a modification of the notion of distance (such as has just been explained in regard to Lobatschewsky's system) pass from our present system to a non-Euclidian system; for the other mode of passing to a non-Euclidian system it would be necessaay to regard our space as a flat three-dimensional space existing in a space of four dimensions (*i.e.*, as the analogue of a plane existing in ordinary space), and to substitute for such flat three-dimensional space a curved three-dimensional space, say of constant positive or negative curvature. In regarding the physical space of our experience as possibly non-Euclidian, Riemann's idea seems to be that of modifying the notion of distance, not that of treating it as a locus in four-dimensional space.

I have just come to speak of four-dimensional space. What meaning do we attach to it? Or can we attach to it any meaning? It may be at once admitted that we cannot conceive of a fourth dimension of space; that space as we conceive of it, and the physical space of our experience, are alike three-dimensional; but we can, I think, conceive of space as being two- or even one-dimensional; we can imagine rational beings living in a one-dimensional space (a line), or in a two-dimensional space (a surface), and conceiving of space accordingly, and to whom, therefore, a two-dimensional space, or (as the case may be) a three-dimensional space, would be as inconceivable as a four-dimensional space is to us. And very curious speculative questions arise. Suppose the one-dimensional space a right line, and that it afterwards becomes a curved line, would there be any indication of the change? Or, if originally a curved line, would there be anything to suggest to them that it was not a right line? Probably not, for a one-dimensional geometry hardly exists. But let the space be two-dimensional, and imagine it originally a plane, and afterwards bent (converted, that is, into some form of developable surface) or converted into a curved surface; or imagine it originally a developable or curved surface. In the former case there should be an indication of the change, for the geometry originally applicable to the space of their experience (our own Euclidian geometry) would cease to be applicable; but the change could not be apprehended by them as a bending or deformation of the plane, for this would imply the notion of a three-dimensional space in which this bending or deformation could take place. In the latter case their geometry would be that appropriate to the developable or curved surface which is their space; viz., this would be their Euclidian geometry: would they ever have arrived at our own more simple system? But take the case where the two-dimensional space is a plane, and imagine the beings of such a space familiar with our own Euclidian plane geometry; if, a third dimension being still inconceivable by them, they were by their geometry or otherwise led to the notion of it, there would be nothing to prevent them from forming a science such as our own science of three-dimensional geometry.

Evidently all the foregoing questions present themselves in regard to ourselves, and to three-dimensional space as we conceive of it, and as the physical space of our experience. And I need hardly say that the first step is the difficulty, and that granting a fourth dimension we may assume as many more dimensions as we please. But whatever answer be given to them, we have, as a branch of mathematics, potentially, if not actually, an analytical geometry of n-dimensional space. I shall have to speak again upon this.

Coming now to the fundamental notion already referred to, that of imaginary magnitude in analysis and imaginary space in geometry, I connect this with two great discoveries in mathematics made in the first half of the seventeenth century,—Harriot's representation of an equation in the form $f(x)=0$, and the consequent notion of the roots of an equation as derived from the linear factors of $f(x)$, (Harriot, 1560—1621; his "Algebra," published after his death, has the date 1631); and Descartes's method of co-ordinates, as given in the "Géometrie," forming a short supplement to his "Traité de la Méthode," &c. (Leyden, 1637).

Taking the coefficients of an equation to be real magnitudes, it at once follows from Harriot's form of an equation that an equation of the order n ought to have n roots. But it is by no means true that there are always n real roots. In particular, an equation of the second order, or quadric equation, may have no real root; but if we assume the existence of a root i of the quadric equation $x^2+1=0$, then the other root is $=-i$; and it is easily seen that every quadric equation (with real coefficients as before) has two roots $a \pm bi$, where a and b are real magnitndes. We are thus led to the conception of an imaginary magnitude, $a+bi$, where a and b are real magnitudes, each susceptible of any positive or negative value, zero included. The general theorem is that, taking the coefficients of the equation to be imaginary magnitudes, then an equation of the order n has always n roots, each of them an imaginary magnitude, and it thus appears that the foregoing form $a+bi$ of imaginary magnitude is the only one that presents itself. Such imaginary magnitudes may be added or multiplied together, or dealt with in any manner; the result is always a like imaginary magnitude. They are thus the magnitudes which are considered in analysis, and analysis is the science of such magnitudes. Observe the leading character that the imaginary magnitude $a+bi$ is a magnitude composed of the two real magnitudes a and b (in the case $b=0$ it is the real magnitude a, and in the case $a=0$ it is the pure imaginary magnitude bi). The idea is that of considering, in place of real magnitudes, these imaginary or complex magnitudes $a+bi$.

In the Cartesian geometry a curve is determined by means of the equation existing between the co-ordinates (x, y) of any point thereof. In the case of a right line this equation is linear; in the case of a circle, or more generally of a conic, the equation is of the second order; and generally, when the equation is of the order n, the curve which it represents is said to be a curve of the order n. In the case of two given curves there are thus two equations satisfied by the co-ordinates (x, y) of the several points of intersection, and these give rise to an equation of a certain order for the co-ordinate x or y of a point of intersection. In the case of a straight line and a circle this is a quadric equation; it has two roots, real or

imaginary. There are thus two values, say of x, and to each of these corresponds a single value of y. There are therefore two points of intersection—viz., a straight line and a circle intersect *always* in two points, real or imaginary. It is in this way that we are led analytically to the notion of imaginary points in geometry. The conclusion as to the two points of intersection cannot be contradicted by experience: take a sheet of paper and draw on it the straight line and circle, and try, But you might say, or at least be strongly tempted to say, that it is meaningless. The question of course arises, What is the meaning of an imaginary point? and further, In what manner can the notion be arrived at geometrically?

There is a well-known construction in perspective for drawing lines through the intersection of two lines, which are so nearly parallel as not to meet within the limits of the sheet of paper. You have two given lines which do not meet, and you draw a third line, which, when the lines are all of them produced, is found to pass through the intersection of the given lines. If instead of lines we have two circular arcs not meeting each other, then we can, by means of these arcs, construct a line; and if on completing the circles it is found that the circles intersect each other in two real points, then it will be found that the line passes through these two points; if the circles appear not to intersect, then the line will appear not to intersect either of the circles. But the geometrical construction being in each case the same, we say that in the second case also the line passes through the two intersections of the circles.

Of course it may be said in reply that the conclusion is a very natural one, provided we assume the existence of imaginary points; and that, this assumption not being made, then, if the circles do not intersect, it is meaningless to assert that the line passes through their points of intersection. The difficulty is not got over by the analytical method before referred to, for this introduces difficulties of its own: is there in a plane a point the coordinates of which have given imaginary values? As a matter of fact we do consider in plane geometry imaginary points introduced into the theory analytically or geometrically as above.

The like considerations apply to solid geometry, and we thus arrive at the notion of imaginary space as a *locus in quo* of imaginary points and figures.

I have used the word imaginary rather than complex, and I repeat that the word has been used as including real. But, this once understood, the word becomes in many cases superfluous, and the use of it would even be misleading. Thus, "a problem has so many solutions"; this means so many imaginary (including real) solutions. But if it were said that the problem had "so many imaginary solutions," the word "imaginary" would here be understood to be used in opposition to real. I give this explanation the better to point out how wide the application of the notion of the imaginary is,—viz., (unless expressly or by implication excluded), it is a notion implied and presupposed in all the conclusions of modern analysis and geometry. It is, as I have said, the fundamental notion underlying and pervading the whole of these branches of mathematical science.

I shall speak later on of the great extension which is thereby given to geometry, but I wish now to consider the effect as regards the theory of a function. In the original point of view, and for the original purposes, a function, algebraic or transcendental, such as $\sqrt{x}$, $\sin x$, or $\log x$, was considered as known, when the value was known for every real value (positive or negative) of the argument; or if for any such values the value of the function became imaginary, then it was enough to know that for such values of the argument there was no real value of the function. But now this is not enough, and to know the function means to know its value—of course, in general, an imaginary value $X+iY$—for every imaginary value $x+iy$ whatever of the argument.

And this leads naturally to the question of the geometrical representation of an imaginary variable. We represent the imaginary variable $x+iy$ by means of a point in a plane, the co-ordinates of which are (x, y). This idea, due to Gauss, dates from about the year 1831. We thus picture to ourselves the succession of values of the imaginary variable $x+iy$ by means of the motion of the representative point; for instance, the succession of values corresponding to the motion of the point along a closed curve to its original position. The value $X+iY$ of the function can of course be represented by means of a point (taken for greater convenience in a different plane), the co-ordinates of which are X, Y.

We may consider in general two points, moving each in its own plane, so that the position of one of them determines the position of the other, and consequently the motion of the one determines the motion of the other; for instance, the two points may be the tracing-point and the pencil of a pentagraph. You may with the first point draw any figure you please, there will be a corresponding figure drawn by the second point: for a good pentagraph, a copy on a different scale (it may be); for a badly-adjusted pentagraph, a distorted copy; but the one figure will always be a sort of copy of the first, so that to each point of the one figure there will correspond a point of the other figure.

In the case above referred to, where one point represents the value $x+iy$ of the imaginary variable, and the other the value $X+iY$ of some function $\phi(x+iy)$ of that variable, there is a remarkable relation between the two figures: this is the relation of orthomorphic projection, the same which presents itself between a portion of the earth's surface, and the representation thereof by a map on the stereographic projection or on Mercator's projection,—viz., any indefinitely small area of the one figure is represented in the other figure by an indefinitely small area of the same shape. There will possibly be for different parts of the figure great variations of scale, but the shape will be unaltered; if for the one area the boundary is a circle, then for the other area the boundary will be a circle; if for one it is an equilateral triangle, then for the other it will be an equilateral triangle.

I have for simplicity assumed that to each point of either figure there corresponds one, and only one, point of the other figure; but the general case is that to each point of either figure there corresponds a determinate number of points in the other figure; and we have thence arising new and very complicated relations which I must just refer to. Suppose that to each point of the first figure there correspond in the second figure two points; say one of them is a red point, the other a blue point; so that, speaking roughly, the second figure consists of two copies of the first figure, a red copy and a blue copy, the one superimposed on the other. But the difficulty is that the two copies cannot be kept distinct from each other. If we consider in the first figure a closed curve of any kind—say, for shortness, an oval—this will be in the second figure represented in some cases by a red oval and a blue oval, but in other cases by an oval half red and half blue; or, what comes to the same thing, if in the first figure we consider a point which moves continuously in any manner, at last returning to its original position, and attempt to follow the corresponding points in the second figure, then it may very well happen that, for the corresponding point of either colour, there will be abrupt changes of position, or say jumps, from one position to another; so that, to obtain in the second figure a continuous path, we must at intervals allow the point to change from red to blue, or from blue to red. There are in the first figure certain critical points called branch-points (*Verzweigungs-punkte*), and a system of lines connecting these, by means of which the colours in the second figure are determined; but it is not possible for me to go further into the theory at present. The notion of colour has of course been introduced only for facility of expression; it it may be proper to add that in speaking of the two figures

I have been following Briot and Bouquet rather than Riemann, whose representation of the function of an imaginary variable is a different one.

I have been speaking of an imaginary variable $(x+iy)$, and of a function $\phi(x+iy)=X+iY$ of that variable, but the theory may equally well be stated in regard to a plane curve: in fact, the $x+iy$ and the $X+iY$ are two imaginary variables connected by an equation; say their values are u and v, connected by an equation $F(u, v)=0$; then, regarding u, v as the co-ordinates of a point *in plano*, this will be a point on the curve represented by the equation. The curve, in the widest sense of the expression, is the whole series of points, real or imaginary, the co-ordinates of which satisfy the equation, and these are exhibited by the foregoing corresponding figures in two planes; but in the ordinary sense the curve is the series of real points, with co-ordinates u, v, which satisfy the equation.

In geometry it is the curve, whether defined by means of its equation, or in any other manner, which is the subject for contemplation and study. But we also use the curve as a representation of its equation—that is, of the relation existing between two magnitudes x, y, which are taken as the co-ordinates of a point on the curve. Such employment of a curve for all sorts of purposes—the fluctuations of the barometer, the Cambridge boat-races, or the Funds—is familiar to most of you. It is in like manner convenient in analysis, for exhibiting the relations between any three magnitudes, x, y, z, to regard them as the co-ordinates of a point in space; and, on the like ground, we should at least wish to regard any four or more magnitudes as the co-ordinates of a point in space of a corresponding number of dimensions. Starting with the hypothesis of such a space, and of points therein each determined by means of its co-ordinates, it is found possible to establish a system of n-dimensional geometry analogous in every respect to our two- and three-dimensional geometries, and to a very considerable extent serving to exhibit the relations of the variables. To quote from my memoir "On Abstract Geometry" (1869):—"The science presents itself in two ways: as a legitimate extension of the ordinary two- and three-dimensional geometries, and as a need in these geometries and in analysis generally. In fact, whenever we are concerned with quantities connected in any manner, and which are considered as variable or determinable, then the nature of the connection between the quantities is frequently rendered more intelligible by regarding them (if two or three in number) as the co-ordinates of a point in a plane or in space. For more than three quantities there is, from the greater complexity of the case, the greater need of such a representation; but this can only be obtained by means of the notion of a space of the proper dimensionality, and to use such representation we require a corresponding geometry. An important instance in plane geometry has already presented itself in the question of the number of curves which satisfy given conditions; the conditions imply relations between the coefficients in the equation of the curve; and for the better understanding of these relations it was expedient to consider the coefficients as the co-ordinates of a point in a space of the proper dimensionality."

It is to be borne in mind that the space, whatever its dimensionality may be, must always be regarded as an imaginary or complex space such as the two- or three-dimensional space of ordinary geometry; the advantages of the representation would otherwise altogether fail to be obtained.

I have spoken throughout of Cartesian coordinates; instead of these it is in plane geometry not unusual to employ trilinear co-ordinates, and these may be regarded as absolutely undermined in their magnitude—viz. we may take x, y, z to be, not equal, but only proportional to the distances of a point from three given lines; the ratios of the co-ordinates (x, y, z) determine the point; and so in one-dimensional geometry, we may have a point determined by the ratio of its two co-ordinates x, y, these co-ordinates being proportional to the distances of the point from two fixed points; and generally in n-dimensional geometry a point will be determined by the ratios of the $(n+1)$ co-ordinates $(x, y, z \ldots)$. The corresponding analytical change is in the expression of the original magnitudes as fractions with a common denominator; we thus, in place of rational and integral non-homogeneous functions of the original variables, introduce rational and integral homogeneous functions (quantics) of the next succeeding number of variables—viz., we have binary quantics corresponding to one-dimensional geometry, tenary to two-dimensional geometry, and so on.

It is a digression, but I wish to speak of the representation of points or figures in space upon a plane. In perspective we represent a point in space by means of the intersection with the plane of the picture (suppose a pane of glass) of the line drawn from the point to the eye, and doing this for each point of the object we obtain a representation or picture of the object. But such representation is an imperfect one, as not determining the object: we cannot by means of the picture alone find out the form of the object; in fact, for a given point of the picture the corresponding point of the object is not a determinate point, but it is a point anywhere in the line joining the eye with the point of the picture. To determine the object we need two pictures, such as we have in a plan and elevation, or, what is the same thing, in a representation on the system of Monge's descriptive geometry. But it is theoretically more simple to consider two projections on the same plane, with different positions of the eye: the point in space is here represented on the plane by means of two points which are such that the line joining them passes through a fixed point of the plane (this point is in fact the intersection with the plane of the picture of the line joining the two positions of the eye); the figure in space is thus represented on the plane by two figures, which are such that the lines joining corresponding points of the two figures pass always through the fixed point. And such two figures completely replace the figure in space; we can by means of them perform on the plane any constructions which could be performed on the figure in space, and employ them in the demonstration of properties relating to such figure. A curious extension has recently been made: two figures in space such that the lines joining corresponding points pass through a fixed point have been regarded by the Italian geometer Veronése as representations of a figure in four-dimensional space, and have been used for the demonstration of properties of such figure.

I referred to the connection of Mathematics with the notions of space and time, but I have hardly spoken of time. It is, I believe, usually considered that the notion of number is derived from that of time; thus Whewell in the work referred to, p. xx., says number is a modification of the conception of repetition, which belongs to that of *time*. I cannot recognise that this is so: it seems to me that we have (independently, I should say, of space or time, and in any case not more depending on time than on space) the notion of plurality; we think of, say the letters, a, b, c, &c., and thence in the case of a finite set—for instance a, b, c, d, e—we arrive at the notion of number; co-ordinating them one by one with any other set of things, or, suppose, with the words first, second, &c., we find that the last of them goes with the word fifth, and we say that the number of things is = five: the notion of cardinal number would thus appear to be derived from that of ordinal number.

Questions of combination and arrangement present themselves, and it might be possible from the mere notion of plurality to develope a branch of mathematical science; this, however, would apparently be of a very limited extent, and it is difficult *not* to introduce into it the notion of number; in fact, in the case of a finite set of things, to avoid asking the question, How many? If we do this, we

have a large enough subject, including the partition of numbers, which Sylvester has called Tactic.

From the notion thus arrived at of an integer number, we pass to that of a fractional number, and we see how by means of these the ratio of any two concrete magnitudes of the same time can be expressed, not with absolute accuracy, but with any degree of accuracy we please: for instance, a length is so many feet, tenths of a foot, hundredths, thousandths, &c.; subdivide as you please, *non constat* that the length can be expressed accurately, we have in fact incommensurables; as to the part which these play in the Theory of Numbers, I shall have to speak presently. for the moment I am only concerned with them in so far as they show that we cannot from the notion of number pass to that which is required in analysis, the notion of an abstract (real and positive) magnitude susceptible of continuous variation. The difficulty is got over by a Postulate. We consider an abstract (real and positive) magnitude, and regard it as susceptible of continuous variation, without in anywise concerning ourselves about the actual expression of the magnitude by a numerical fraction or otherwise.

There is an interesting paper by Sir W. R. Hamilton, "Theory of Conjugate Functions, or Algebraical Couples: with a preliminary and elementary Essay on Algebra as the Science of Pure Time," 1833-35 (*Trans. R. I. Acad.*, t. 17), in which, as appears by the title, he purposes to show that algebra is the science of pure time. He states there, in the General Introductory Remarks, his conclusions: first, that the notion of time is connected with existing algebra; second, that this notion or intuition of time may be unfolded into an independent pure science; and third, that the science of pure time thus unfolded is co-extensive and identical with algebra, so for as algebra itself is a science; and to sustain his first conclusion he remarks that "the history of algebraic science shows that the most remarkable discoveries in it have been made either expressly through the notion of *time*, or through the closely connected (and in some sort coincident) notion of continuous progression. It is the genius of algebra to consider what it reasons upon as *flowing*, as it was the genius of geometry to consider what it reasoned on as *fixed*. . . . . And generally the revolution which Newton made in the higher parts of both pure and applied algebra was founded mainly on the notion of *fluxion*, which involves the notion of *time*." Hamilton uses the term algebra in a very wide sense, but whatever else he includes under it, he includes all that in contradistinction to the Differential Calculus would be called algebra. Using the word in this restricted sense, I cannot myself recognise the connection of algebra with the notion of time: granting that the notion of continuous progression presents itself, and is of importance, I do not see that it is in anywise the fundamental notion of the science. And still less can I appreciate the manner in which the author connects with the notion of time his algebraical couple, or imaginary magnitude $a+bi$ ($a+b\sqrt{-1}$, as written in the memoir).

I would go further: the notion of continuous variation is a very fundamental one, made a foundation in the Calculus of Fluxions (if not always so in the Differential Calculus) and presenting itself or implied throughout in mathematics: and it may be said that a change of any kind takes place only in time; it seems to me, however, that the changes which we consider in mathematics are for the most part considered quite irrespectively of time.

It appears to me that we do not have in Mathematics the notion of time until we bring it there: and that even in kinematics (the science of motion) we have very little to do with it; the motion is a hypothetical one; if the system be regarded as actually moving, the rate of motion is altogether undetermined and immaterial. The relative rates of motion of the different points of the system are nothing else than the ratios of purely geometrical quantities, the infinitely short distances simultaneously described, or which might be simultaneously described, by these points respectively. But whether the notion of time does or does not sooner enter into mathematics, we at any rate have the notion in Mechanics, and along with it several other new notions.

Regarding Mechanics as divided into Statics and Dynamics, we have in dynamics the notion of time, and in connection with it that of velocity: we have in statics and dynamics the notion of force; and also a notion which in its most general form I would call that of corpus: viz., this may be, the material point or particle, the flexible inextensible string or surface, or the rigid body, of ordinary mechanics; the incompressible perfect fluid of hydrostatics and hydrodynamics; the ether of any undulatory theory; or any other imaginable corpus; for instance, one really deserving of consideration in any general treatise of mechanics is a developable or skew surface with absolutely rigid generating lines, but which can be bent about these generating lines, so that the element of surface between two consecutive lines rotates as a whole about one of them. We have besides, in dynamics necessarily, the notion of mass or inertia.

We seem to be thus passing out of pure mathematics into physical science; but it is difficult to draw the line of separation, or to say of large portions of the "Principia," and the "Mécanique céleste," or of the whole of the "Mécanique analytique," that they are not pure mathematics. It may be contended that we first come to physics when we attempt to make out the character of the corpus as it exists in nature. I do not at present speak of any physical theories which cannot be brought under the foregoing conception of mechanics.

I must return to the Theory of Numbers; the fundamental idea is here integer number: in the first instance positive integer number, but which may be extended to include negative integer number and zero. We have the notion of a product, and that of a prime number, which is not a product of other numbers; and thence also that of a number as the product of a determinate system of prime factors. We have here the elements of a theory in many respects analogous to algebra: an equation is to be solved—that is, we have to find the integer values (if any) which satisfy the equation; and so in other cases: the congruence notation, although of the very highest importance, does not affect the character of the theory.

But as already noticed we have incommensurables, and the consideration of these gives rise to a new universe of theory. We may take into consideration any surd number such as $\sqrt{2}$, and so consider numbers of the form $a+b\sqrt{2}$, (a and b any positive or negative integer numbers not excluding zero); calling these integer numbers, every problem which before presented itself in regard to integer nnmbers in the original and ordinary sense of the word presents itself equally in regard to integer numbers in this new sense of the word; of course all definitions must be altered accordingly: an ordinary integer, which is in the ordinary sense of the word a prime number, may very well be the product of two integers of the form $a+b\sqrt{2}$, and consequently not a prime number in the new sense of the word. Among the incommensurables which can be thus introduced into the Theory of Numbers (and which was in fact *first* so introduced) we have the imaginary i of ordinary analysis: viz., we may eonsider numbers $a+bi$ (a and b ordinary positive or negative integers, not excluding zero), and, calling these integer numbers, establish in regard to them a theory analogous to that which exists for ordinary real integers. The point whch I wish to bring out is that the imaginary i does not in the Theory of Numbers occupy a unique position, such as it does in analysis and geometry; it is in the Theory of Numbers one out of an indefinite multitude of incommensurables.

I said that I would speak to you, not of the utility of mathematics in any of the questions of common life or of physical science, but rather of the obligations of mathematics to these different subjects. The consideration

which thus presents itself is in a great measure that of the history of the development of the different branches of mathematical science in connection with the older physical sciences, Astronomy and Mechanics: the mathematical theory is in the first instance suggested by some question of common life or of physical science, is pursued and studied quite independently thereof, and perhaps after a long interval comes in contact with it, or with quite a different question. Geometry and algebra must, I think, be considered as each of them originating in connection with objects or questions of common life—geometry, notwithstanding its name, hardly in the measurement of land, but rather from the contemplation of such forms as the straight line, the circle, the ball, the top (or sugar loaf): the Greek geometers appropriated for the geometrical forms corresponding to the last two of these, the words κῶνος and σφαῖρα, our cone and sphere, and they extended the word cone to mean the complete figure obtained by producing the straight lines of the surface both ways indefinitely. And so algebra would seem to have arisen from the sort of easy puzzles in regard to numbers which may be made, either in the picturesque forms of the Bija-Ganita with its maiden with the beautiful locks, and its swarms of bees amid the fragrant blossoms, and the one queen-bee left humming around the lotus flower; or in the more prosaic form in which a student has presented to him in a modern text-book a problem leading to a simple equation.

The Greek geometry may be regarded as beginning with Plato (B.C. 430-347): the notions of geometrical analysis, loci, and the conic sections are attributed to him, and there are in his Dialogues many very interesting allusions to mathematical questions: in particular the passage in the "Theætetus," where he affirms the incommensurability of the sides of certain squares. But the earliest extant writings are those of Euclid (B.C. 285): there is hardly anything in mathematics more beautiful than his wondrous fifth book; and he has also in the seventh, eighth, ninth, and tenth books fully and ably developed the first principles of the Theory of Numbers, including the theory of incommensurables. We have next Apollonius (about B.C. 247), and Archimedes (B.C. 287-212), both geometers of the highest merit, and the latter of them the founder of the science of statics (including therein hydrostatics): his dictum about the lever, his Εὕρηκα, and the story of the defence of Syracuse, are well known. Following these we have a worthy series of names, including the astronomers Hipparchus (B.C. 150) and Ptolemy (A.D. 125), and ending, say, with Pappus (A.D. 400), but continued by their Arabian commentators, and the Italian and other European geometers of the sixteenth century and later, who pursued the Greek geometry.

The Greek arithmetic was, from the want of a proper notation, singularly cumbrous and difficult; and it was for the astronomical purposes superseded by the sexagesimal arithmetic, attributed to Ptolemy, but probably known before his time. The use of the present so-called Arabic figures became general among Arabian writers on arithmetic and astronomy about the middle of the tenth century, but was not introduced into Europe until about two centuries later. Algebra among the Greeks is represented almost exclusively by the treatise of Diophantus (A.D. 150), in fact a work on the Theory of Numbers containing questions relating to square and cube numbers, and other properties of numbers, with their solutions: this has no historical connection with the later algebra, introduced into Italy from the East by Leonardi Bonacci of Pisa (A.D. 1202-1208) and successfully cultivated in the fifteenth and sixteenth centuries by Lucus Paciolus, or de Burgo, Tartaglia, Cardan, and Ferrari. Later on, we have Vieta (1540-1603), Harriot, already referred to, Wallis, and others.

Astronomy is of course intimately connected with geometry; the most simple facts of observation of the heavenly bodies can only be *stated* in geometrical language: for instance, that the stars describe circles about the pole-star, or that the different positions of the sun among the fixed stars in the course of the year form a circle. For astronomical calculations it was found necessary to determine the arc of a circle by means of its chord: the notion is as old as Hipparchus, a work of whom is referred to as consisting of twelve books on the chords of circular arcs; we have (A.D. 125) Ptolemy's "Almagest," the first book of which contains a table of arcs and chords with the method of construction; and among other theorems on the subject he gives there the theorem afterwards inserted in Euclid (Book VI. Prop. D) relating to the rectangle contained by the diagonals of a quadrilateral inscribed in a circle. The Arabians made the improvement of using in place of the chord of an arc the sine, or half chord of double the arc; and so brought the theory into the form in which it is used in modern trigonometry; the before-mentioned theorem of Ptolemy, or rather a particular case of it, translated into the notation of sines, gives the expression for the sine of the sum of two arcs in terms of the sines and cosines of the component arcs; and it is thus the fundamental theorem on the subject. We have in the fifteenth and sixteenth centuries a series of mathematicians who with wonderful enthusiasm and perseverance calculated tables of the trigonometrical or circular functions, Purbach, Müller, or Regiomontanus, Copernicus, Reinhold, Maurolycus, Vieta, and many others; the tabulations of the functions tangent and secant are due to Reinhold and Maurolycus respectively.

Logarithms were invented, not exclusively with reference to the calculation of trigonometrical tables, but in order to facilitate numerical calculations generally; the invention is due to John Napier of Merchiston, who died in 1618 at 67 years of age; the notion was based upon refined mathematical reasoning on the comparison of the spaces described by two points, the one moving with a uniform velocity, the other with a velocity varying according to a given law. It is to be observed that Napier's logarithms were nearly but not exactly those which are now called (sometimes Napierian, but more usually) hyperbolic logarithms—those to the base e; and that the change to the base 10 (the great step by which the invention was perfected for the object in view) was indicated by Napier but actually made by Henry Briggs, afterwards Savilian Professor at Oxford (d. 1630). But it is the hyperbolic logarithm which is mathematically important. The direct function e^x or exp. x, which has for its inverse the hyperbolic logarithm, presented itself, but not in a prominent way. Tables were calculated of the logarithms of numbers, and of those of the trigonometrical functions.

The circular functions and the logarithm were thus invented each for a practical purpose, separately and without any proper connection with each other. The functions are connected through the theory of imaginaries and form together a group of the utmost importance throughout mathematics: but this is mathematical theory; the obligation of mathematics is for the discovery of the functions.

Forms of spirals presented themselves in Greek architecture, and the curves were considered mathematically by Archimedes; the Greek geometers invented some other curves, more or less interesting, but recondite enough in their origin. A curve which might have presented itself to anybody, that described by a point in the circumference of a rolling carriage wheel, was first noticed by Mersenne in 1615, and is the curve afterwards considered by Roberval, Pascal, and others under the name of the Roulette, otherwise the Cycloid. Pascal (1623-1662) wrote at the age of seventeen his 'Essais pour les Coniques' in seven short pages, full of new views on these curves, and in which he gives, in a paragraph of eight lines, his theorem of the inscribed hexagon.

Kepler (1571-1630) by his empirical determination of the laws of planetary motion, brought into connection with astronomy one of the forms of conic, the ellipse, and established a foundation for the theory of gravitation.

Contemporary with him for most of his life, we have Galileo (1564-1642), the founder of the science of dynamics; and closely following upon Galileo we have Isaac Newton (1643-1727):— the 'Philosophiæ naturalis Principia Mathematica' known as the 'Principia' was first published in 1687.

The physical, statical, or dynamical questions which presented themselves before the publication of the 'Principia' were of no particular mathematical difficulty, but it is quite otherwise with the crowd of interesting questions arising out of the theory of gravitation, and which, in becoming the subject of mathematical investigation, have contributed very much to the advance of mathematics. We have the problem of two bodies, or what is the same thing, that of the motion of a particle about a fixed centre of force, for any law of force; we have also the (mathematically very interesting) problem of the motion of a body attracted to two or more fixed centres of force; then, next preceding that of the actual solar system—the problem of three bodies; this has ever been and is far beyond the power of mathematics, and it is in the lunar and planetary theories replaced by what is mathematically a different problem, that of the motion of a body under the action of a principal central force and a disturbing force; or (in one mode of treatment) by the problem of disturbed elliptic motion. I would remark that we have here an instance in which an astronomical fact, the observed slow variation of the orbit of a planet, has directly suggested a mathematical method, applied to other dynamical problems, and which is the basis of very extensive modern investigations in regard to systems of differential equations. Again, immediately arising out of the theory of gravitation, we have the problem of finding the attraction of a solid body of any given form upon a particle, solved by Newton in the case of a homogeneous sphere, but which is far more difficult in the next succeeding cases of the spheroid of revolution (very ably treated by Maclaurin) and of the ellipsoid of three unequal axes: there is perhaps no problem of mathematics which has been treated by as great a variety of methods, or has given rise to so much interesting investigation as this last problem of the attraction of an ellipsoid upon an interior or exterior point. It was a dynamical problem, that of vibrating strings, by which Lagrange was led to the theory of the representation of a function as the sum of a series of multiple sines and cosines; and connected with this we have the expansions in terms of Legendre's functions P_n, suggested to him by the question just referred to of the attraction of an ellipsoid; the subsequent investigations of Laplace on the attractions of bodies differing slightly from the sphere led to the functions of two variables called Laplace's functions. I have been speaking of ellipsoids, but the general theory is that of attractions, which has become a very wide branch of modern mathematics; associated with it we have in particular the names of Gauss, Lejeune-Dirichlet, and Green; and I must not omit to mention that the theory is now one relating to n-dimensional space. Another great problem of celestial mechanics, that of the motion of the earth about its centre of gravity, in the most simple case, that of a body not acted upon by any forces, is a very interesting one in the mathematical point of view.

I may mention a few other instances where a practical or physical question has connected itself with the development of mathematical theory. I have spoken of two map projections—the stereographic, dating from Ptolemy; and Mercator's projection, invented by Edward Wright about the year 1600: each of these, as a particular case of the orthomorphic projection, belongs to the theory of the geometrical representation of an imaginary variable. I have spoken also of perspective, and of the representation of solid figures employed in Monge's descriptive geometry. Monge, it is well known, is the author of the geometrical theory of the curvature of surfaces and of curves of curvature: he was led to this theory by a problem of earthwork; from a given area covered with earth of uniform thickness, to carry the earth and distribute it over an equal given area, with the least amount of cartage. For the solution of the corresponding problem in solid geometry he had to consider the intersecting normals of a surface, and so arrived at the curves of curvature. (See his Mémoire sur les Déblais et les Remblois,' *Mem. de l'Acad.*, 1781.) The normals of a surface are, again, a particular case of a doubly infinite system of lines, and are so connected with the modern theories of congruences and complexes.

The undulatory theory of light led to Fresnel's wave-surface, a surface of the fourth order, by far the most interesting one which had then presented itself. A geometrical property of this surface, that of having tangent planes each touching it along a plane curve (in fact a circle), gave to Sir W. R. Hamilton the theory of conical refraction. The wave surface is now regarded in geometry as a particular case of Kummer's quartic surface, with sixteen conical points and sixteen singular tangent planes.

My imperfect acquaintance as well with the mathematics as the physics prevents me from speaking of the benefits which the theory of Partial Differential Equations has received from the hydrodynamical theory of vortex motion, and from the great physical theories of heat, electricity, magnetism, and energy.

It is difficult to give an idea of the vast extent of modern mathematics. This word 'extent' is not the right one:— I mean extent crowded with beautiful detail—not an extent of mere uniformity such as an objectless plain, but of a tract of beautiful country seen at first in the distance but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower. But, as for anything else, so for a mathematical theory—beauty can be perceived, but not explained. As for mere extent, I can perhaps best illustrate this by speaking of the dates at which some of the great extensions have been made in several branches of mathematical science.

As regards geometry, I have already spoken of the invention of the Cartesian co-ordinates (1637). This gave to geometers the whole series of geometric curves of higher order than the conic sections: Curves of the third order, or cubic curves; curves of the fourth order, or quartic curves; and so on indefinitely. The first fruits of it were Newton's "Enumeratio linearum tertii ordinis," and the extremely interesting investigations of Maclaurin as to corresponding points on a cubic curve. This was at once enough to show that the new theory of cubic curves was a theory quite as beautiful and far more extensive than that of conics. And I must here refer to Euler's remark in the paper "Sur une contradiction apparente dans la théorie des courbes planes" ("Berlin Memoirs," 1748), in regard to the nine points of intersection of two cubic curves (viz., that when eight of the points are given the ninth point is thereby completely determined): this is not only a fundamental theorem in cubic curves (including in itself Pascal's theorem of the hexagon inscribed in a conic), but it introduces into plane geometry a new notion—that of the point-system, or system of the points of intersection of two curves.

A theory derived from the conic, that of polar reciprocals, led to the general notion of geometrical duality—viz., that in plane geometry the point and the line are correlative figures; and founded on this we have Plücker's great work, the "Theorie der Algebraischen Curven" (Bonn, 1839), in which he establishes the relation which exists between the order and class of a curve and the number of its different point- and line-singularities (Plücker's six equations). It thus appears that the true division of curves is not a division according to order only, but according to order and class, and that the curves of a given order and class are again to be divided into families according to their singularities: this is not a mere subdivision, but is really a widening of the field of investigation; each such family of curves is in itself a

subject as wide as the totality of the curves of a given order might previously have appeared.

We *unite* families by considering together the curves of a given *Geschlecht*, or deficiency; and in reference to what I shall have to say on the Abelian functions, I must speak of this notion introduced into geometry by Riemann in the memoir "Theorie der Abel'schen Functionen," Crelle, t. 54 (1857). For a curve of a given order, reckoning cusps as double points, the deficiency is equal to the greatest number $\frac{1}{2}(n-1)(n-2)$ of the double points which a curve of that order can have, less the number of double points which the curve actually has. Thus a conic, a cubic with one double point, a quartic with three double points, &c., are all curves of the deficiency 0; the general cubic is a curve, and the most simple curve, of the deficiency 1; the general quartic is a curve of deficiency 3; and so on. The deficiency is usually represented by the letter p. Riemann considers the general question of the rational transformation of a plane curve: viz., here the co-ordinates, assumed to be homogeneous or trilinear, are replaced by any rational and integral functions, homogeneous of the same degree in the new co-ordinates; the transformed curve is in general a curve of a different order, with its own system of double points; but the deficiency p remains unaltered; and it is on this ground that he unites together and regards as a single class the whole system of curves of a given deficiency p. It must not be supposed that all such curves admit of rational transformation the one into the other: there is the further theorem that any curve of the class depends, in the case of a cubic, upon one parameter, but for $p>1$ upon $3p-3$ parameters, each such parameter being unaltered by the rational transformation; it is thus only the curves having the same one parameter, or $3p-3$ parameters, which can be rationally transformed the one into the other.

Solid geometry is a far wider subject: there are more theories, and each of them is of greater extent. The ratio is not that of the numbers of the dimensions of the spaces considered, or, what is the same thing, of the elementary figures—point and line in the one case; point, line, and plane in the other case—belonging to these spaces respectively, but it is a very much higher one. For it is very inadequate to say that in plane geometry we have the curve, and in solid geometry the curve and surface: a more complete statement is required for the comparison. In plane geometry we have the curve, which may be regarded as a singly infinite system of points, and also as a singly infinite system of lines. In solid geometry we have, first, that which under one aspect is the curve, and under another aspect the developable, and which may be regarded as a singly infinite system of points, of lines, or of planes; secondly, the surface, which may be regarded as a doubly infinite system of points or of planes, and also as a special triply infinite system of lines (viz., the tangent-lines of the surface are a special complex): as distinct particular cases of the former figure, we have the plane curve and the cone; and as a particular case of the latter figure, the ruled surface or singly infinite system of lines; we have *besides* the congruence, or doubly infinite system of lines, and the complex, or triply infinite system of lines. But, even if in solid geometry we attend only to the curve and the surface, there are crowds of theories which have scarcely any analogues in plane geometry. The relation of a curve to the various surfaces which can be drawn through it, or of a surface to the various curves that can be drawn upon it, is different in kind from that which in plane geometry most nearly corresponds to it, the relation of a system of points to the curves through them, or of a curve to the points upon it. In particular, there is nothing in plane geometry corresponding to the theory of the curves of curvature of a surface. To the single theorem of plane geometry, a right line is the shortest distance between two points, there correspond in solid geometry two extensive and difficult theories—that of the geodesic lines upon a given surface, and that of the surface of minimum area for any given boundary. Again, in solid geometry we have the interesting and difficult question of the representation of a curve by means of equations; it is not every curve, but only the curve which is the complete intersection of two surfaces, which can be properly represented by two equations $(x, y, z, w)^m = 0$, $(x, y, z, w)^n = 0$, in quadriplanar co-ordinates; and in regard to this question, which may also be regarded as that of the classification of curves in space, we have quite recently three elaborate memoirs by Nöther, Halphen, and Valentiner respectively.

In n-dimensional geometry, only isolated questions have been considered. The field is simply too wide; the comparison with each other of the two cases of plane geometry and solid geometry is enough to show how the complexity and difficulty of the theory would increase with each successive dimension.

* * * *

Outside of ordinary mathematics, we have some theories which must be referred to: algebraical, geometrical, logical. It is, as in many other cases, difficult to draw the line; we do in ordinary mathematics use symbols not denoting quantities, which we nevertheless combine in the way of addition and multiplication, $a+b$, and ab, and which may be such as not to obey the commutative law $ab=ba$, in particular this is or may be so in regard to symbols of operation; and it could hardly be said that any development whatever of the theory of such symbols of operation did not belong to ordinary algebra. But I do separate from ordinary mathematics the system of multiple algebra or linear associative algebra, developed in the valuable memoir by the late Benjamin Peirce, "Linear Associative Algebra" (1870, reprinted 1881 in the *American Journal of Mathematics*, vol. iv., with notes and addenda by his son, C. S. Peirce); we here consider symbols A, B, &c., which are linear functions of a determinate number of letters or units i, j, k, l, &c., with coefficients which are ordinary analytical magnitudes, real or imaginary (viz., the coefficients are in general of the form $x+iy$, where i is the before-mentioned imaginary or $\sqrt{-1}$ of ordinary analysis). The letters i, j, &c., are such that every binary combination i^2, ij, ji, &c. (the ij being in general not $=ji$), is equal to a linear function of the letters, but under the restriction of satisfying the associative law: viz., for each combination of three letters $ij.k$ is $= i.jk$, so that there is a determinate and unique product of three or more letters; or, what is the same thing, the laws of combination of the units i, j, k, are defined by a multiplication table giving the values of i^2, ij, ji, &c.; the original units may be replaced by linear functions of these units, so as to give rise, for the units finally adopted, to a multiplication table of the most simple form; and it is very remarkable, how frequently in these simplified forms we have nilpotent or idempotent symbols ($i^2=0$, or $i^2=i$, as the case may be), and symbols i, j, such that $ij=ji=0$; and consequently how simple are the forms of the multiplication tables which define the several systems respectively.

I have spoken of this multiple algebra before referring to various geometrical theories of earlier date, because I consider it as the general analytical basis, and the true basis, of these theories. I do not realise to myself directly the notions of the addition or multiplication of two lines, areas, rotations, forces, or other geometrical, kinematical, or mechanical entities; and I would formulate a general theory as follows:—Consider any such entity as determined by the proper number of parameters a, b, c (for instance, in the case of a finite line given in magnitude and position, these might be the length, the co-ordinates of one end, and the direction-cosines of the line considered as drawn from this end); and represent it by or connect it with the linear function $ai+bj+ck+$&c., formed with these parameters as coefficients, and with a given set of units, i, j, k, &c. Conversely, any such linear function represents an entity of the kind in question. Two given entities are represented by two linear functions; the sum

of these is a like linear function representing an entity of the same kind, which may be regarded as the sum of the two entities; and the product of them (taken in a determined order, when the order is material) is an entity of the same kind, which may be regarded as the product (in the same order) of the two entities. We thus establish by definition the notion of the sum of the two entities, and that of the product (in a determinate order, when the order is material) of the two entities. The value of the theory in regard to any kind of entity would of course depend on the choice of a system of units, i, j, k . . with such laws of combination as would give a geometrical or kinematical or mechanical significance to the notions of the sum and product as thus defined.

Among the geometrical theories referred to, we have a theory (that of Argand, Warren, and Peacock) of imaginaries in plane geometry; Sir W. R. Hamilton's very valuable and important theory of Quaternions; the theories developed in Grassmann's "Ausdehnungslehre," 1841 and 1862; Clifford's theory of Biquaternions, and recent extensions of Grassmann's theory to non-Euclidian space, by Mr. Homersham Cox. These different theories have of course been developed, not in anywise from the point of view in which I have been considering them, but from the points of view of their several authors respectively.

The literal symbols x, y, &c., used in Boole's "Laws of Thought" (1854), to represent things as subjects of our conceptions, are symbols obeying the laws of algebraic combination (the distributive, commutative, and associative laws) but which are such that for any one of them, say x, we have $x - x^2 = 0$, this equation not implying (as in ordinary algebra it would do) either $x = 0$ or else $x = 1$. In the latter part of the work relating to the Theory of Probabilities there is a difficulty in making out the precise meaning of the symbols, and the remarkable theory there developed has, it seems to me, passed out of notice, without having been properly discussed. A paper by the same author, "Of Propositions numerically Definite" (*Camb. Phil. Trans.*, 1869) is also on the borderland of logic and mathematics. It would be out of place to consider other systems of mathematical logic, but I will just mention that Mr. C. S. Peirce in his "Algebra of Logic" (*Amer. Math. Journal*, vol. iii.), establishes a notation for relative terms, and that these present themselves in connection with the systems of units of the linear associative algebra.

Connected with logic, but primarily mathematical and of the highest importance, we have Schubert's "Abzählende Geometrie" (1878). The general question is, How many curves or other figures are there which satisfy given conditions? for example, How many conics are there which touch each of five given conics? The class of questions, in regard to the conic, was first considered by Chasles, and we have his beautiful theory of the characteristics μ, ν, of the conics which satisfy four given conditions; questions relating to cubics and quartics were afterwards considered by Maillard and Zeuthen; and in the work just referred to the theory has become a very wide one. The noticeable point is that the symbols used by Schubert are in the first instance, not numbers, but mere logical symbols: for example, a letter g denotes the condition that a line shall cut a given line; g^2 that it shall cut each of two given lines; and so in other cases; and these logical symbols are combined together by algebraical laws: they first acquire a numerical signification when the number of conditions becomes equal to the number of parameters upon which the figure in question depends.

In all that I have last said in regard to theories outside of ordinary mathematics, I have been still speaking on the text of the vast extent of modern mathematics. In conclusion I would say that mathematics have steadily advanced from the time of the Greek geometers. Nothing is lost or wasted; the achievements of Euclid, Archimedes, and Apollonius are as admirable now as they were in their own days. Descartes's method of co-ordinates is a possession for ever. But mathematics have never been cultivated more zealously and diligently, or with greater success, than in this century—in the last half of it, or at the present time: the advances made have been enormous, the actual field is boundless, the future full of hope. In regard to pure mathematics we may most confidently say:—

> Yet I doubt not through the ages one increasing purpose runs,
> And the thoughts of men are widened with the process of the suns.

PURIFICATION OF SULPHURETTED HYDROGEN GAS FOR CHEMICO-JUDICIAL INVESTIGATIONS.

By W. LENZ.

IT has been repeatedly and urgently pointed out that the presence of arsenic in the iron sulphide used for generating sulphuretted hydrogen gas in chemico-legal investigations is liable to give off an arseniferous gas and thus introduce arsenic into the matter under examination. The author has repeatedly convinced himself, by means of Fresenius and Babo's very delicate method of reducing arsenic in a current of carbon dioxide that various sorts of commercial iron sulphide, sold as "free from arsenic" and "absolutely free from arsenic" on treatment with non-arsenical acids developed a sulphuretted hydrogen gas which conveyed not inconsiderable quantities of arsenic into the acid solution under examination.

Washing with water by no means frees the gas from arsenic, but this may be effected by washing with dilute hydrochloric acid. The author uses for this purpose a system of four washing bottles, set in a square upon a thick plate of iron and heated during the experiment to 60°—70°. Each of the bottles contains about 22 c.c. of liquid; that in the first is a mixture of 1 part officinal acid (?) and 2 parts of water; the second contains a part of such acid to 4 parts of water, the third 1 part to 8 of water, and the fourth pure water. The bottles are closed with corks, not caoutchouc stoppers. The connection is made with glass tubes or tubes of non-vulcanised india-rubber. Sulphuretted hydrogen washed in this manner has been passed for hours into warm dilute hydrochloric acid without producing a deposit of arsen-sulphide, whilst a current of gas evolved from the same materials but washed only in water gave an arsenical precipitate on being passed into dilute acid for half an hour. —*Zeitschrift fur Anal. Chemie.*

To this paper may be appended a memoir by W. Fresenius, found in the same number of the *Zeitschrift* on the presence of arsenic in glass as a source of error in the detection of arsenic. The author remarks that whilst in toxicological researches the reagents have been always carefully tested for arsenic, no one has suspected that the glass apparatus employed, if containing arsenic, might give occasion to errors. Such a result, however, appears, according to the author's observations, perfectly possible. It is well known that arsenious acid is often used in the manufacture of glass as a decolourising agent, and it seems that latterly arsenic is more generally and more abundantly present in glass, whether from a more copious addition of arsenious acid, or from the use of strongly arseniferous materials. The author's attention was first drawn to this subject when testing a precipitate formed by sulphuretted hydrogen for arsenic by Fresenius and Babo's process. The bulk of the precipitate, mixed with soda and potassium cyanide, placed in a tube of Bohemian glass, was heated in a current of carbonic acid for a short time and not too violently. There appeared only a very slight arsenical deposit. On repeating the experiment with the smaller residual portion of the precipitate, heat-

ing more strongly and for a longer time in a tube of the same glass, an extremely strong arsenical mirror. This phenomenon led to the supposition that the latter mirror was due to the glass which had been attacked by the melting mixture of potassium cyanide and sodium carbonate. To test this supposition the author made a blank experiment in a tube of the same glass, with a mixture of sodium carbonate and potassium cyanide perfectly free from arsenic. The result perfectly verified the supposition: if the heat was short and feeble there was no deposit, but after prolonged and vigorous heating a very strong mirror appeared in the tube. The author then examined certain kinds of glass for arsenic, and studied the influence which this impurity may have in the various methods for determining arsenic. The qualities tried were a Bohemian glass with which the foregoing experiments had been made, containing 0·20 per cent of arsenic and 0·05 of lead; a refractory glass from Thüringen containing o 08 arsenic and 0·96 lead, and a third refractory glass containing per gramme a quantity of arsenic not ponderable and 0·09 per cent of lead. On making blank experiments as above with all these three kinds of glass, mirrors were obtained, that with the last kind being by far the slightest.

If the mixture was placed in a porcelain boat which had been previously ignited, and was thus prevented from coming in direct contact with the glass, the experiment being otherwise conducted exactly according to Fresenius and Babo's method, no arsenical mirror was obtained even on intense and prolonged heating. Pure sodium carbonate alone, if heated in a current of pure hydrogen gas, gave an arsenical with all three kinds of glass, though very slight with the last mentioned kind. A current of pure hydrogen alone produced no arsenical mirror, but with the two first mentioned kinds of glass there was produced a brown colouration at the spot where the flame played directly upon the glass. This browning has generally been attributed to the presence of lead, but the author considers it due to arsenic, as it was strongest in the Bohemian glass, which contained much arsenic but little lead, and did not appear at all in the third, which contained twice as much lead and a mere trace of arsenic.

Further experiments are made to show whether aqueous solutions of acids or alkalies were capable of taking up arsenic from glass. It was found that such an extraction is possible in case of alkaline liquids, but is not to be apprehended with acids.

The presence of arsenic in the glass is not likely to lead to error in the Marsh process, as it would be detected in the preliminary examination before adding the suspected substance.

In the Fresenius and Babo process, the substance with the reduction mixture should be placed in a porcelain boat, introduced into a tube of glass as free as possible from arsenic, and cautiously dried in the current of carbon dioxide before applying a high temperature. The author finally remarks that non-arsenical glass was formerly a common article of commerce, though it cannot now be procured.—*Zeitschrift fur Anal. Chemie.*

The Chemical Laboratory of Wiesbaden.—In the Summer term, 1883, there were 49 students on the books. Of these, 36 were from Germany, 3 from England, 3 from North America, 2 from Luxemburg, 2 from Sweden, and 1 from Austro-Hungary, Spain, and Russia. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment: Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architect F. Brahm. The assistants in the instruction laboratory were two in number; in the private laboratory, fourteen; and in the Versuchsstation, two. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tungsten.

THE various compounds of tungsten must first be brought to the state of ammoniacal or alkaline tungstates,—a transformation easily effected.

The mixture of tungstate and of gallium compounds is mixed with a decided excess of hydrochloric acid and evaporated in heat almost to dryness. During this operation the white tungstic acid is partially dehydrated, and turns yellow. We add then a little water, and evaporate afresh without entirely drying up the mass, upon which is then poured a considerable quantity of water very slightly acidulated with hydrochloric acid; it is then slightly heated and filtered.

The clear liquid, free from tungstic acid, contains the gallium. The precipitate retains only traces of gallium, which are easily removed by re-dissolving in ammonia, and evaporating a second time in presence of an excess of hydrochloric acid as indicated above.

Separation from Phosphoric Acid.

The author has studied three methods which give good results:—

1. In a liquid which contains from a quarter to one-third of its volume of concentrated hydrochloric acid, potassium ferrocyanide throws down the gallium, whilst the phosphoric acid remains in solution.

The precipitate of gallium ferrocyanide must be carefully washed with water, strongly charged with hydrochloric acid, or it may retain traces of phosphoric acid.

2. The solution is mixed with about one-third of its volume of concentrated nitric acid and the phosphoric acid is precipitated by means of ammonium molybdate, proceeding in the usual manner for determining phosphoric acid.

The separation of the gallium and the molybdenum contained in the filtrate is effected by the method described in the CHEMICAL NEWS, vol. xlvii., p. 62.

3. The detection of small quantities of gallium disseminated in large masses of phosphates is very readily effected by adding to the hydrochloric solution, slightly acid, an excess of acid ammonium acetate, and a certain quantity of arsenious acid dissolved in water, and treating the whole with a current of sulphuretted hydrogen.

The arsenic sulphide carries down the gallium; it is well washed with water containing a little acid ammonium acetate and sulphuretted hydrogen, and is then re-dissolved in *aqua regia* containing a large excess of hydrochloric acid. The nitric acid is destroyed by long boiling; the arsenic acid is reduced by sulphurous acid, and the very acid hydrochloric acid is treated with a current of sulphuretted hydrogen. Arsenic sulphide falls free from gallium, which is found in the filtrate.—*Comptes Rendus.*

CORRESPONDENCE.

SEPARATION OF IRON AND ALUMINIUM.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlviii., p. 114, appears a translation of a memoir on the behaviour of the acetates of chromium, iron, and aluminium, by B. Reinitzer, concluding with the statement that "the method of separating ferric and aluminium salts in the form of basic acetates entirely loses its applicability in presence of chromic salts."

My own experiments conducted me to the same result many years ago, as will be seen by reference to "Bowman's Practical Chemistry," 7th Edition, 1878 (Table xiii., p. 160, and Note *q*, p. 172), of which I have the honour of being the

EDITOR.

September 7, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 8, August 20, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 148.

Researches on Nitrogen Iodide: on Chemical Radiometers, or Photometers, with Nitrogen Iodide; on the Preparation in the Cold of Nitrogen, Ammonium Iodide, and Iodide, under the Influence of Light; and on the Double Copper and Nitrogen Iodide.—Antony Guyard.—This paper will, if possible, be inserted at length.

No. 9, August 27, 1883.

New Method of Preparing Phosphorus Oxychloride.—E. Dervin.—The author places in a stoppered retort holding from 750 to 1000 c.c., 500 grms. phosphorus trichloride, which must be pure, containing especially no free phosphorus, and connects the neck of the retort to an ascending refrigerator by means of a thick caoutchouc tube. When the apparatus is thus arranged there are dropped in at the tubulure by means of a funnel about 4 grms. potassium chlorate which has been previously fused and finely pulverised. When this dose has been introduced the retort is stoppered. The liquid heats and enters into ebullition; when this has ceased a second dose of chlorate is introduced with the same precautions, stoppering the retort as rapidly as possible, for this time ebullition sets in almost instantly. The additions of chlorate are thus continued until 160 grms. have been added. The end of the preparation is distinctly marked by the fact that the three last doses, being superfluous, no longer occasion ebullition in the liquid. The process requires about four hours. The whole is then distilled in the oil-bath, and the last portions of the oxy-chloride are expelled by a current of dry carbonic acid.

Zeitschrift für Analytische Chemie. Vol. xxii., Part 3, 1883.

Electrolytic Determinations and Separations.—E. Hintz.—C. Luckow has stated that silver is deposited at the negative pole under the action of the current in a very bulky state from the solutions of the silver salts in ammonia or ammonium carbonate, whilst there is formed at the positive pole a little peroxide, which is soon reduced to metallic silver. J. Krutwig mentions now that silver may be deposited from an ammoniacal solution in presence of ammonium sulphate in a state fit for weighing if a current is applied at first only capable of yielding 150 c.c. of detonating gas hourly, and doubling its strength after the first half-hour. In two hours time 0·1 grm. of silver is deposited. The deposit is washed with hot water, which is slowly poured into the platinum capsule serving as a negative electrode. For separating iron from manganese Classen and Von Reiss propose to submit the double oxalates to the action of the current in presence of ammonium oxalate. Classen mentions since that the separation of the iron can be accelerated if, instead of ammonium oxalate, a mixture of potassium oxalate and ammonium oxalate is used for the formation of the double salts. The author recommends that the decomposition should be begun with two Bunsen elements with their electrodes at the respective distance of 3 centimetres, and as soon as manganese is deposited the strength of the current should be increased by the introduction of one or two more elements. After the reduction of the iron is completed Classen pours off the supernatant liquid, boils after the addition of soda-lye in order to decompose the acid ammonium carbonate formed during the electrolysis, adding further sodium carbonate, and finally a few c.c. of sodium hypochlorite. The hydrated manganese peroxide is quickly deposited, filtered off, washed with hot water containing a little ammonium nitrate, and the precipitate is weighed as manganoso-manganic oxide. For the separation of iron, manganese, and phosphoric acid, Classen separates the iron from the manganese electrolytically as above, precipitates the latter as peroxide, acidulates the filtrate with hydrochloric acid, and determines the phosphoric acid as usual. If sulphuric acid is to be determined along with iron and manganese, the two metals are separated electrolytically from the double oxalates and the sulphuric acid is determined in the filtrate with barium chloride without previously removing the last traces of manganese with sodium hypochlorite. The separation of iron, manganese, and alumina is also effected as above, the alumina being found in the liquid filtered off from the manganese peroxide. The current must not be allowed to act after the iron is deposited. The separation of iron from chromium is effected electrolytically by throwing down the iron as metal from the ammonium double oxalates, and then oxidising the chromic oxide to chromic acid. If iron, manganese, chrome, and alumina are to be separated, the current is allowed to act upon the ammonium double oxalates until the conversion of the chromic oxide into chromic acid is complete. The liquid is poured off, boiled, precipitated while hot with soda-lye, and a few c.c. of sodium hypochlorite are added. The deposit of manganese contains a little chrome, and it is therefore, after filtration, re-dissolved in hydrochloric acid, and again precipitated with soda and sodium hypochlorite. The united filtrates, freed from manganese, are boiled with ammonium chloride in excess till all the alumina is deposited. All the chrome is contained in the filtrate as chromic acid. In the electrolysis of liquids containing nickel and manganese as double oxalates, the nickel is first deposited as metal, and then the manganese as peroxide. The separation of cobalt, zinc, copper, bismuth, and cadmium from manganese is effected in the same manner. The separation of iron from glucina can be effected electrolytically if double ammonium oxalates are formed by means of an excess of ammonium oxalate (without the potassium salt), and the iron is eliminated by a feeble current. In separating iron, glucina, and alumina, the same method is adopted. After the reduction of the iron the liquid is poured into another platinum capsule, and the current is kept up till all the alumina is deposited. The glucina is then thrown down from the filtrate by boiling. The separation of iron from zirconia and vanadium is effected in the same way as from glucina.

Detection and Determination of Small Quantities of Silver in Galena in the Moist Way.—J. Krutwig.—Already noticed.

Detection of Tin in Presence of Antimony.—M. Pattison Muir.—From the CHEMICAL NEWS.

Notes on the Determination of Nitrogen, especially in Manures.—W. Fresenius.—This memoir will appear at length.

Determination of Sugar.—MM. Soxhlet, Degener, and others.—This memoir does not admit of useful abstraction.

A New Adulterant of Ground Pepper.—C. Girard.—The material used consists of the kernels of olive-berries, ground. If the suspected mixture is scattered upon a mixture of equal volumes of glycerin and water, the pepper floats upon the surface, whilst the olive-kernels sink.

Application of Sulpho-diazo-benzolic Acid for the Detection of Glucose.—M. Penzoldt.—The reagent is dissolved in 60 parts of water, made slightly alkaline with potassa, and added to an equal volume of urine which has been made strongly alkaline. If glucose is present the urine takes a light claret colour, which gradually deepens.

Examination of Fats.—This paper will be inserted at length.

Adulteration of Saffron.—J. Biel.—Genuine saffron does not stain petroleum ether, and can thus be distinguished from calendula flowers dyed with dinitro-cresol.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

FIRTH COLLEGE, SHEFFIELD.—*Professor of Chemistry.*—W. Carleton Williams, B.Sc., F.C.S.

Demonstrator and Assistant Lecturer.—L. T. O'Shea, F.C.S.

The Session will commence on Wednesday, October 3, 1883.

First Year's Course.—Chemistry of the Non-Metallic Elements. Monday, Wednesday, Friday, from 10 to 11 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals: Organic Chemistry. Tuesday, Thursday, Saturday, from 11 to 12 a.m. £3 13s. 6d.

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Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day Students:—Six hours per week, £4 8s.; Nine, £6 10s.; Twelve, £8; Eighteen, £11 4s.; Twenty-four, £14; Thirty, £16 16s.; Thirty-six, £19 2s.

Day Students may not enter for less than six hours a week. Students joining the Laboratory at Christmas will be charged two-thirds, and at Easter one-third of the Fees for the whole Session.

Fees for short periods (working thirty-six hours per week):—For one month, £3 13s. 6d.; two months, £6 6s.; three, £9 9s.; four, £12 18s. 6d.; five, £14 3s. 6d.

An arrangement has been entered into with the Science and Art Department, South Kensington, which will enable Science Teachers to work in the Chemical Laboratory for two days a week on payment of one-quarter of the usual fee, the Department being willing to pay the remainder under certain conditions, of which full information may be obtained on application to the Registrar.

Evening Classes.—Lectures, Tuesday and Friday, 7 to 8; Class, 8 to 9. Fee, 5s. per term, or 9s. per two terms. Laboratory instruction, Monday and Wednesday, 6 to 9. Sessional Fee, three hours per week, £2 5s.; six, £4 8s.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Agent in Decolourising Sugar.—Can any correspondent tell me what is the acting agent in animal charcoal in decolourising sugar solutions?—SUGAR REFINER.

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MR. FREDK. JAS. LLOYD, F.C.S., Assistant Chemist, Royal Agricultural Society, will deliver a Course of Forty Lectures on the above subject, Mondays and Thursdays, at 6 p.m. during the Winter Session.—For particulars apply to J. W. CUNNINGHAM, Secretary.

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1244.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By J. H. GLADSTONE, Ph.D., F.R.S., V.P.C.S., President of the Section.

A sectional address usually consists either of a review of the work done in the particular science during the past year, or of an exposition of some branch of that science to which the speaker has given more especial attention. I propose to follow the latter of these practices, and shall ask the indulgence of my brother chemists while I endeavour to place before them some thoughts on the subject of Elements.

Though theoretical and practical chemistry are now intertwined, with manifest advantage to each, they appear to have been far apart in their origin. Practical chemistry arose from the arts of life, the knowledge empirically and laboriously acquired by the miner and metallurgist, the potter and the glass-worker, the cook and the perfumer. Theoretical chemistry derived its origin from cosmogony. In the childhood of the human race the question was eagerly put, "By what process were all things made?" and some of the answers given started the doctrine of elements. The earliest documentary evidence of the idea is probably contained in the Shoo King, the most esteemed of the Chinese classics for its antiquity. It is an historical work, and comprises a document of still more venerable age, called "The Great Plan, with its Nine Divisions," which purports to have been given by Heaven to the Great Yu, to teach him his royal duty and "the proper virtues of the various relations." Of course there are wide differences of opinion as to its date, but we can scarcely be wrong in considering it as older than Solomon's writings. The First Division of the Great Plan relates to the Five Elements. "The first is named Water; the second, Fire; the third, Wood; the fourth, Metal; the fifth, Earth. The nature of water is to soak and descend; of fire, to blaze and ascend; of wood, to be crooked and to be straight; of metal, to obey and to change; while the virtue of the earth is seen in seed-sowing and ingathering. That which soaks and descends becomes salt; that which blazes and ascends becomes bitter; that which is crooked and straight becomes sour; that which obeys and changes becomes acrid; and from seed-sowing and ingathering comes sweetness."*

A similar idea of five elements was also common among the Indian races, and is stated by Prof. Rodwell to have been in existence before the fifteenth century B.C., but, though the number is the same, the elements themselves are not identical with those of the ancient Chinese classic; thus, in the Institutes of Menu, the "subtle ether" is spoken of as being the first created, from which, by transmutation, springs air, whence, by the operation of a change, rises light or fire; from this comes water, and from water is deposited earth. These five are curiously correlated with the five senses, and it is very evident that they are not looked upon as five independent material existences, but as derived from one another. This philosophy was accepted alike by Hindoos and Buddhists. It was largely extended over Asia, and found its way into Europe. It is best known to us in the writings of the Greeks. Among these people, however, the elements were reduced to four—fire, air, earth, and water—though Aristotle endeavoured to restore the "blue ether" to its position as the most subtle and divine of them all. It is true that the fifth element, or "quinta essentia," was frequently spoken of by the early chemists, though the idea attaching to it was somewhat changed, and the four elements continued to retain their place in popular apprehension, and still retain it, even among many of the scholars who take degrees at our universities. The claim of wood to be considered an element seems never to have been recognised in the West, unless, indeed, we are to seek this origin for the choice of the word ὕλη to signify that original chaotic material out of which, according to Plato and his school, all things were created.* The idea also of a primal element, from which the others, and everything else, were originated, was common in Greece, the difficulty being to decide which of the four had the greatest claim to this honour. Thales, as is well known, in the sixth century B.C. affirmed that water was the first principle of things; but Anaxamenes afterwards looked upon air, Heraclytus upon fire, and Theracleides on earth, as the primal element. This notion of elements, however, was essentially distinct from our own. It was always associated with the idea of the genesis of matter rather than with its ultimate analysis, and the idea of *simple* as contrasted with *compound* bodies probably never entered into the thoughts of the contending philosophers.

The modern idea appears to have had a totally different origin, and we must again travel back to China. There, also in the sixth century B.C., the great philosopher Lao-tse was meditating on the mysteries of the world and the soul, and his disciples founded the religion of Taou. They were materialists; nevertheless they believed in a "finer essence," or spirit, that rises from matter, and may become a star; thus they held that the souls of the five elements, water, metal, fire, wood, and earth, arose and became the the five planets. These speculations naturally led to a search after the sublimated essences of things, and the means by which this immortality might be secured. It seems that at the time of Tsin-she-hwang, the builder of the Great Wall, about two centuries before Christ, many romantic stories were current of immortal men inhabiting islands in the Pacific Ocean. It was supposed that in these magical islands was found the "herb of immortality" growing, and that it gave them exemption from the lot of common mortals. The emperor determined to go in search of these islands, but some untoward event always prevented him.†

Some two or three centuries after this a Taouist, named Weipahyang, wrote a remarkable book called "The Uniting Bond." It contains a great deal about the changes of the heavenly bodies, and the mutual relation of Heaven and men; and then the author proceeds to explain some transformations of silver and water. About elixir he tells us, "What is white when first obtained becomes red after manipulation on being formed into the elixir" ("tan," meaning red or elixir). "That substance, an inch in diameter, consists of the black and the white, that is, water and metal combined. It is older than heaven and earth. It is most honourable and excellent. Around it, like a wall, are the sides of the cauldron. It is closed up and sealed on every side, and carefully watched. The thoughts must be undisturbed, and the temper calm, and the hour of its perfection anxiously waited for. The false chemist passes through various

* Quoted from the translation by the Rev. Dr. Legge. In that most obscure classic, the *Yi-King*, fire and water, wind and thunder, the ocean and the mountains, appear to be recognised as the elements.

* Students of the Apocrypha will remember the expression in the "Book of Wisdom," xi., 17, "ἡ παντοδύναμός σου χεὶρ καὶ κτίσασα τὸν κόσμον ἐξ ἀμόρφου ὕλης" ("Thy Almighty hand, that made the world of matter without form"). The same book contains two allusions to the ordinary elements, vii., 17, and xix., 18 to 20. The word στοιχεῖον is used in the New Testament only in a general sense (2 Pet., iii., 10), or in its more popular meaning of the first steps in knowledge.

† Nearly all the above statements relating to this Taouist alchemy are derived from the writings of the Rev. Joseph Edkins, of Pekin, and the matter is treated in greater detail in an article on the "Birth of Alchemy," in the *Argonaut*, vol. iii., p. 1.

operations in vain. He who is enlightened expels his evil passions, is delighted morning and night, forgets fame and wealth, comprehends the true objects of life, and gains supernatural powers. He cannot then be scorched by fire, nor drowned in water, &c. &c. . . . The cauldron is round like the full moon, and the stove beneath is shaped like the half moon. The lead ore is symbolised by the White Tiger; and it, like metal amongst the elements, belongs to the West. Mercury resembles the sun, and forms itself into sparkling globes; it is symbolised by the Blue Dragon belonging to the East, and it is assigned to the element wood. Gold is imperishable. Fire does not injure its lustre. Like the sun and moon it is unaffected by time. Therefore the elixir is called 'the Golden Elixir.' Life can be lengthened by eating the herb called Hu ma; how much more by taking the elixir, which is the essence of gold, the most imperishable of all things! The influence of the elixir, when partaken of, will extend to the four limbs; the countenance will become joyful; white hair will be turned black; new teeth will grow in the place of old ones, and age at once become youth. . . . Lead ore and mercury are the bases of the process by which the elixir is prepared; they are the hinge upon which the principles of light and darkness revolve."

This description suggests the idea that the elixir of the Taouists was the red sulphide of mercury—vermillion—for the preparation of which the Chinese are still famous. That Weipahyang believed in his own philosophy is testified by a writer named Ko-hung, who, about a century afterwards, wrote the lives of celebrated Taouists. He tells how the philosopher, after preparing the elixir, took it, with his disciples, into a wood, and gave it first to his dog, then took it himself, and was followed by one of his pupils. They all three died, but, it appears, rose to life again, and to immortality. This brilliant example did not remain without imitators; indeed, two emperors of the Tang family are said to have died from partaking of the elixir. This circumstance diminished its popularity, and alchemy ceased to be practised in the Celestial Empire.

At the beginning of the seventh century the doctrine of Lao-tse was in great favour at the Chinese court; learning was encouraged, and there was much enterprise. At the same time the disciples of Mahomed carried their arms and his doctrines over a large portion of Asia, and even to the Flowery Land. Throughout the eighth century there were frequent embassies between eastern and western Asia, wars with the Caliphs, and even a matrimonial alliance. We need not wonder, therefore, that the teachings of the Taouist alchemists penetrated westward to the Arabian philosophers. It was at this period that Yeber-Abou-Moussah-Djafer-al-Sofé, commonly called Geber, a Sabæan of great knowledge, started what to the West was a new philosophy about the transmutation of metals, the Philosopher's Stone, and the Elixir of Life; and this teaching was couched in highly poetic language, mixed with astrology and accompanied by religious directions and rites. He held that all metals were composed of mercury, sulphur, and arsenic, in various proportions, and that the noblest metal could be procured only by a very lengthy purification. It was in the salts of gold and silver that he looked for the Universal Medicine. Geber himself was an experimental philosopher, and the belief in transmutation led to the acquirement of a considerable amount of chemical knowledge amongst the alchemists of Arabia and Europe. This gradually brought about a conviction that the three reputed elementary bodies, mercury, sulphur, and salt or acid, were not really the originators of all things. There was a transition period, during which the notion was itself suffering a transmutation. The idea became gradually clearer that all material bodies were made up of certain constituents, which could not be decomposed any further, and which, therefore, should be considered as elementary. The introduction of quantitative methods compelled the overflow of mediæval chemistry, and led to the placing of the conception of simple and compound bodies upon the foundation of scientific fact. Lavoisier, perhaps, deserves the greatest credit in this matter, while the labours of the other great chemists of the eighteenth and the beginning of the nineteenth centuries were in a great measure directed to the analysis of every conceivable material, whether solid, liquid, or gaseous. These have resulted in the table of so-called elements, now nearly seventy in number, to which fresh additions are constantly being made.

Of this ever-growing list of elements not one has been resolved into simpler bodies for three-quarters of a century; and we, who are removed by two or three generations from the great builders of our science, are tempted to look upon these bodies as though they were really simple forms of matter, not only unresolved, but unresolvable. The notation we employ favours this view and stamps it upon our minds.

Is it, however, a fact that these reputed elements are really simple bodies? or, indeed, are they widely different in the nature of their constitution from those bodies which we know to be chemical compounds? Thus, to take a particular instance, are fluorine, chlorine, bromine, and iodine essentially distinct in their nature from the compound halogens, cyanogen, sulphocyanogen, ferricyanogen, &c.? Are the metals lithium, sodium, and potassium, essentially distinct from such alkaline bases as ammonium, ethylamine, di-ethylamine, &c.? No philosophical chemist would probably venture to answer this question categorically with either "yes" or "no." Let us endeavour to approach it from three different points of attack—(1) the evidence of the spectroscope, (2) certain peculiarities of the atomic weights, and (3) specific refraction.

1. *The Spectroscope.*—It was at first hoped that the spectroscope might throw much light upon the nature of elements, and might reveal a common constituent in two or more of them; thus, for instance, it was conceivable that the spectrum lines of bromine or iodine vapour might consist of the rays given by chlorine *plus* some others. All expectations of this have hitherto been disappointed: what we do frequently find is a certain similarity of character among the spectra of analogous elements, not rays of identically the same refrangibility. Yet, on the other hand, it must not be supposed that a negative result disproves the compound nature of elements, for as investigation proceeds it becomes more and more clear that the spectrum of a compound is not made up of the spectra of its component parts.

Again, the multiplicity of rays given out by some elements, when heated, in a gaseous condition, such as iron, has been supposed to indicate a more complex constitution than in the case of those metals, such as magnesium, which give a more simple spectrum. Yet it is perfectly conceivable that this may be due to a complexity of arrangement of atoms all of the same kind.

Again, we have changes of a spectrum at different temperatures; new rays appear, others disappear; or even there occurs the very remarkable change from a fluted spectrum to one of sharp lines at irregular intervals, or to certain recurring groups of lines. This, in all probability, does arise from some redistribution, but it may be a redistribution in a molecular grouping of atoms of the same kind, and not a dissociation or rearrangement of dissimilar atoms.

A stronger argument has been derived from the revelations of the spectroscope in regard to the luminous atmospheres of the sun. There we can watch the effect of heat enormously transcending that of our hottest furnaces, and of movements compared with which our hurricanes and whirlwinds are the gentlest of zephyrs. Mr. Lockyer, in studying the prismatic spectra of the luminous prominences or spots of the sun, has frequently observed that on certain days certain lines, say of the iron spectrum, are non-existent, and on other days certain other lines disappear, and that in almost endless variety; and he has also remarked that occasionally certain lines of the iron spectrum will be crooked or displaced, thus showing the vapour to be in very rapid motion, while others are straight,

and therefore comparatively at rest. Now, as a gas cannot be both at rest and in motion at the same time and the same place, it seems very clear that the two sets of lines must originate in two distinct layers of atmosphere, one above the other, and Mr. Lockyer's conclusion is that the iron molecule was dissociated by heat, and that its different constituents, on account of their different volatility, or some other cause, had floated away from one another. This seems to me the easiest explanation of the phenomenon; and, as dissociation by heat is a very common occurrence, there is no *a priori* improbability about it. But we are not shut up to it, for the different layers of atmosphere are certainly at different temperatures, and most probably of different composition. If they are of different temperatures, the variations of the spectrum may only be an extreme case of what must be acknowledged to be a fact by everyone more or less—that bodies emit, or cease to emit, different rays as their temperature increases, and notably when they pass from the liquid to the gaseous condition. And again, if the composition of the two layers of atmosphere be different, we have lately learnt how profoundly the admixture of a foreign substance will sometimes modify a luminous spectrum.

2. *Peculiarities of Atomic Weights.*—At the meeting of this Association at Ipswich, in 1851, M. Dumas showed that in several cases analogous elements form groups of three, the middle one of which has an atomic weight intermediate between those of the first and third, and that many of its physical and chemical properties are intermediate also. During the discussion upon his paper, and, subsequently,* attention was drawn to the fact that this is not confined to groups of three, but that there exists many series of analogous elements having atomic weights which differ by certain increments, and that these increments are in most cases multiples of 8. Thus we have lithium, 7; sodium, 23, *i. e.* $7+16$; potassium, 39, *i. e.* $7+(16\times2)$; and the more recently discovered rubidium, 85, *i.e.* $7+(16\times5)$ nearly; and cæsium, 133, *i e.* $7+(16\times8)$ nearly. This is closely analogous to what we find in organic chemistry, where there are series of analogous bodies playing the part of metals, such as hydrogen, methl, ethyl. &c., differing by an increment which has the atomic weight 14, and which we know to be CH_2. Again, there are elements with atomic weights nearly the same or nearly multiples of one another, instances of which are to be found in the great platinum group and the great cerium group.† This suggests the analogy of isomeric and polymeric bodies. There is also this remarkable circumstance: the various members of such a group as either of those just mentioned are found together at certain spots on the surface of the globe, and scarcely anywhere else. The chemist may be reminded of how in the dry distillation of some organic body he has obtained a mixture of polymerised hydrocarbons, and may perhaps be excused if he speculates whether in the process of formation of the platinum or the cerium group, however and whenever it took place, the different elements had been made from one another and imperfectly polymerised.

But this is not the largest generalisation in regard to the peculiarities of these atomic weights. Newlands showed that, by arranging the numbers in their order, the octaves presented remarkable similarities, and, on the same principle, Mendelieff constructed his well-known table. I may remind you that in this table the atomic weights are arranged in horizontal and vertical series, those in the vertical series differing from one another, as a rule, by the before-mentioned multiples of 8—namely 16, 16, 24, 24, 24, 24, 32, 32—the elements being generally analogous in their atomicity and in other chemical characters. Attached to the elements are figures, representing various physical properties, and these in the horizontal series appear as periodic functions of the atomic weights. The table is incomplete, especially in its lower portions but, with all its imperfections and irregularities, there can be no doubt that it expresses a great truth of nature. Now, if we were to interpolate the compound bodies which act like elements—methyl, 15; ammonium, 18; cyanogen, 20—into Mendelieff's table, they would be utterly out of place, and would upset the order both of chemical analogy and of the periodicity of the physical properties.

Specific Refraction.—The specific refraction has been determined for a large majority of the elements, and is a very fundamental property, which belongs to them apparently in all their combinations, so long at least as the atomicity* is unchanged. If the figures representing this property be inserted into Mendelieff's table, we find that in the vertical columns the figures almost invariably decrease as the atomic weights increase. If, however, we look along the horizontal columns, or better still if we plot the figures in the table by which Lothar Meyer has shown graphically that the molecular volume is a periodic function of the atomic weights, we shall see that they arrange themselves in a series of curves similar to but not at all coincident with his. The observations are not so complete or accurate as those of the molecular volumes, but they seem sufficient to establish the fact, while the points of the curves would appear to be, not the alkaline metals, as in Meyer's diagram, but hydrogen, phosphorus, and sulphur, titanium and vanadium, selenium, antimony. Now, if we were to insert the specific refractions of cyanogen, ammonium, and methyl into this table, we should again show that it was an intrusion of strangers not in harmony with the family of elements.

But there is another argument to be derived from the action of light. The refraction equivalent of a compound body is the sum of the refraction equivalents of its compounds; and, if there is anything known for certain in the whole subject, it is that the refraction equivalent of an organic compound advances by the same quantity (7·6) for every increment of CH_2. If, therefore, the increment between the different members of a group of analogous elements, such as the alkaline metals, be of the same character, we may expect to find that there is a regular increase of the refraction equivalent for each addition of 16. But this is utterly at variance with fact: thus, in the instance above quoted, the refraction equivalent of lithium being 3·8, that of sodium is 4·8, of potassium 8·1, of rubidium 14·0, and of cæsium about 13·7. Neither does the law obtain in those series in which the increment is not a multiple of 8, as in the case of the halogens, where the increment of atomic weight is 45, and the refraction equivalents are chlorine 9·9, bromine 15·3, and iodine 24·5.

The refraction equivalents of isomeric bodies are generally identical; and the refraction equivalents of polymeric bodies are in proportion to their atomic weights. Among the groups of analogous elements of the same, or nearly the same, atomic weight we do find certain analogies: thus cobalt and nickel are respectively 10·8 and 10·4, while iron and manganese are respectively 12·0 and 12·2. But, as far as observation has gone at present, we have reason to conclude that if metals stand to one another in the ratio of 2 : 1 in atomic weight, their refraction equivalents are much nearer together than that; while on the other hand, the equivalent of sulphur, instead of being the double of that of oxygen, is at least five times as great

The general tendency of these arguments is evidently to show that the elementary radicals are essentially different from the compound radicals, though their chemical functions are similar.

There remains still the hypothesis that there is a "primordial element," from which the others are derived by transmutation. With the sages of Asia it was the "blue ether," with Thales water, with Dr. Prout hydrogen. The earlier views have passed away, and the claims of hydro-

* *Phil. Mag.*, May, 1853.

† Another curious instance is the occurrence of nickel and cobalt in all meteoric irons, with occasionally chromium or manganese, the atomic weights and other properties of which are very similar.

* This exception includes not merely such changes as that from a ferrous to a ferric salt, but the different ways in wihch the carbon is combined in such bodies as ethene, benzene, and pyrene.

gen are being fought out by some of our ablest analysts on the battle-field of atomic weights and their rigorous determination.

There does not appear to be any argument which is fatal to the idea that two or more of our supposed elements may differ from one another rather in form than in substance, or even that the whole seventy are only modifications of a prime element; but chemical analogies seem wanting. The closest analogy would be if we could prepare two allotropic conditions of some body, such as phosphorus or cyanogen, which should carry their allotropism into all their respective compounds, no compound of the one form being capable of change into a compound of the other. Our present knowledge of allotropism, and of variations in atomicity, affords little, if any, promise of this.

The remarkable relations between the atomic weights of the elements, and many peculiarities of their grouping, force upon us the conviction that they are not separate bodies created without reference to one another, but that they have been originally fashioned, or have been built up from one another, according to some general plan. This plan we may hope gradually to understand better; but if we are ever to transform one of these supposed elements into another, or to split up one of them into two or three dissimilar forms of matter, it will probably be by the application of some method of analysis hitherto unknown.

Nothing can be of greater promise than the discovery of new methods of research; hence I need make no apology to others who have lately done excellent work in chemistry if I single out the Bakerian Lecture of this year, by Mr. Crookes, on "Radiant Matter Spectroscopy." It relates to the prismatic analysis, not of the light transmitted or absorbed in the ordinary way by a solid or liquid, nor of that given out by incandescent gas, but the analysis of the fluorescence that manifests itself in certain bodies when they are exposed to an electric discharge in a highly exhausted vacuum. He describes, in an interesting and even amusing manner, his three years' quest after the origin of a certain citron band, which he observed in the spectrum of the fluorescence of many substances, till he was led into that wonderful labyrinth of uncertain elements which are found together in samarskite, and eventually he proved the appearance to be due to yttrium. As the test is an extremely delicate one, he has obtained evidence of the very general dissemination of that element, in very minute quantities—and not always very minute, for the polypes that built up a certain pink coral were evidently able to separate the earth from the sea water, as their calcareous secretion contained about ½ per cent of yttrium. We have reason to hope that this is only the first instalment of discoveries to be made by this new method of research.

I cannot conclude without a reference to the brightening prospects of technical chemistry in this country. I do not allude to the progress of any particular industry, but to the increased facilities for the education of those engaged in the chemical manufactures. First as to the workpeople. Hitherto the young artizan has had little opportunity of learning at school what would be of the greatest service to him in his after career. The traditions of the Middle Ages were all in favour of literary culture for the upper classes, and the education suited for these has been retained in our schools for the sons of the people. It is true that some knowledge of common things has been given in the best schools, and the Education Department has lately encouraged the teaching of certain sciences in the upper standards. In the Mundella Code, however, which came into operation last year, "elementary science" may receive a grant in all the classes of a boys' or girls' school, and in the suggested scheme there is mentioned simple lessons on "the chemical and physical principles involved in one of the chief industries of England, among which Agriculture may be reckoned," while "Chemistry" is inserted among "the specific subjects of instruction," that may be given to the older children. It is impossible, as yet, to form an estimate of the extent to which managers and teachers have availed themselves of this permission, for the examinations of her Majesty's Inspectors under the new code have only just commenced; but one of the best of the Board schools in London has just passed satisfactorily in chemistry both with boys and girls. I trust that in those parts of the country where chemical industries prevail chemistry may be largely taken up in our elementary schools.

The great deficiency in our present educational arrangements is the want of the means of teaching a lad who has just left the common school the principles of that industry by which he is to earn his livelihood. The more purely scientific chemistry, however, may be learnt by him now in those evening classes which may be formed under the Education Department, as well as in those that have long been established under the Science and Art Department. The large amount of attention that is now being given to the subject of technical education is creating in our manufacturing centres many technical classes and colleges for students of older growth.

As to inventors and the owners of our chemical factories, in addition to the Chemical Society and the Chemical Institute, there has recently been founded the Society of Chemical Industry. It came into existence with much promise of success; at the close of its second year it numbered 1,400 members; it has now powerful sections in London, Manchester, Liverpool, Newcastle, and Birmingham; and it diffuses information on technical subjects in a well-conducted monthly journal.

May the abstract science and its useful applications ever prove helpful to one another, and become more and more one chemistry for the benefit of mankind.

ON THE NITROCYANIDE OF SILVER.

By C. L. BLOXAM.

This salt is described in Gmelin's "Handbook of Chemistry," English Translation, vol. viii., p. 29, as formed by dissolving recently-precipitated silver cyanide in a somewhat concentrated solution of silver nitrate. Its composition is given as $AgO.NO_5+2AgCy$, which, in the atomic notation, becomes $AgNO_3.2AgCy$. In support of this formula (which is also given in "Watts's Dictionary") a determination of silver by Wöhler is given, as 69·74 per cent, whereas the formula requires 73·97.

I prepared a quantity of the salt by dissolving pure silver cyanide in a nearly saturated boiling solution of silver nitrate. On cooling, the liquid was filled with beautiful needles, which shrank into a much smaller bulk on moving the beaker. As water decomposes the salt, it was dried by repeated pressure between filter-paper.

20·51 grains of the salt, dried at 100° C., became slightly brown, but lost only 0·07 grain (=0·34 per cent).

52·1 grains, of another preparation, lost 0·27 grain (=0·53 per cent). As the salt detonates when further heated, it was mixed with 3 parts of ignited sodium carbonate, and heated in a current of dry air which was afterwards passed into sulphuric acid bulbs previously weighed.

27·85 grains of the salt gave, when heated by a Bunsen burner, only 0·3 grain of water (=1·07 per cent), confirming the statement in Gmelin, that the salt does not contain water (as an essential constituent).

20·44 grains of the salt dried at 100°, dissolved in concentrated nitric acid, and precipitated by hydrochloric acid, gave 18·458 grains of silver chloride, corresponding to 68·09 per cent of silver.

15·22 grains of another sample, which had been dried at 100° and finely powdered, were digested with water till completely decomposed. The undissolved silver cyanide was collected on a filter, washed, and ignited. It gave 5·27 grains of silver present as cyanide. The filtrate and

washings, precipitated by hydrochloric acid, gave 13·92 grains of silver chloride, corresponding to 10·47 grains of silver present as nitrate, or almost exactly twice that present as cyanide.

The composition of the salt therefore is $AgCN.2AgNO_3$.

	Found.	Calculated.
Ag as AgCN	22·97	22·77
Ag as $AgNO_3$	45·64	45·55
	68·61	68·32

The slight excess of silver would be expected from the discolouration of the salt in drying.

The mother-liquor from the crystals contains silver nitrate only.

In the margin of the paragraph on nitrocyanide of silver in Gmelin, I find a manuscript note by Hadow to the effect that "crystals found by Dawson to produce *pin-holes* in collodion negatives proved to be of this composition. March 17, 1865." At that date Hadow was Demonstrator of Chemistry and Dawson Lecturer on Photography in this College.

King's College, London, September 10, 1883.

ON COMPLEX INORGANIC ACIDS.

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

My further investigations of the complex inorganic acids have yielded results of very interesting character, and the field of work has become so extensive that it is simply impossible for one man to attempt to cover the whole ground. In the papers which I have already published I have described only binary compounds, such as may be expressed by the general formula—

$$m RO_3.n R'_2O_5.p R''_2O.$$

In this formula m may represent any even number from 10 to 48 inclusive, R either molybdenum or tungsten, n is 2 in the compounds described, r, p the number of molecules of base (old style), while R' represents either phosphorus or arsenic. I have now generalised these results still further. In place of phosphorus or arsenic we may have vanadium or antimony, and probably niobium and tantalum, as I stated long since in a preliminary notice. In place of oxides of the type R'_2O_5, we may have those of the type R'_2O_3, as, for example, As_2O_3, Sb_2O_3, P_2O_3, and probably V_2O_3. Thus, the formula of a phosphoroso-molybdate of ammonium is—

$$24MoO_3.2P_2O_3.5(NH_4)_2O+20Aq.$$

These compounds by oxidation pass into salts containing the higher oxides of the type R'_2O_5. Salts containing boric oxide, B_2O_3, have been described by Klein. Even hypo-phosphorous acid is capable of forming similiar compounds. Thus, I have obtained a hypo-phospho-molybdate with the formulæ—

$$24MoO_3.6PO_2.6(NH_4)_2O+7Aq.$$

Perhaps further study will show that the analyses may be represented by a simpler formula. A different mode of expression must be adopted, if, with Wurtz, we write the formula of hypo-phosphorous acid :—

$$O=P.OH.H_2,$$

so that we have, probably, erther

$$O=P.H_2.(ONH_4) \text{ or } O=P.H.NH_4.OH$$

as the term representing the phosphorus contained, the type being still $O=P\equiv(OH)_3$ as in phosphoric acid, part of the ammonium being united to WO_3 in the structural formula. Well defined and beautifully crystalline vanadio-molybdates have respectively the formulæ—

$$6MoO_3.V_2O_5.2(NH_4)_2O.H_2O+4Aq$$
$$16MoO_3.V_2O_5.5BaO.H_2O+28Aq$$

which correspond to types of phospho-molybdates and phospho-tungstates. In like manner in two vanadio-tungstates of sodium the ratios of the tungstic and vanadic oxides are respectively as 10 : 1 and as 18 : 1.

Ternary series containing tungstic or molybdic oxide united to two other oxides also exist in large number. Thus, in the general formula—

$$m RO_3.n R'_2O_5.p R''_2O_5.r R'''_2O$$

RO_3 may be either tungstic or molybdic oxide, R'_2O_5 and R''_2O_5 two different oxides of the same type, as, for example, phosphoric and vanadic oxides. I am not prepared to say that *any* two known oxides of the type R_2O_5 may enter together into such compounds, but it is not impossible that such is the case. Examples of these salts are the following :—

$$14MoO_3.8V_2O_5.P_2O_5.8(NH_4)_2O+50Aq$$
$$48MoO_3.V_2O_5.2P_2O_5.7(NH_4)_2O+30Aq$$
$$60WO_3.V_2O_5.3P_2O_5.10(NH_4)_2O+60Aq$$
$$16WO_3.3V_2O_5.P_2O_5.5(NH_4)_2O+37Aq$$

I refrain from theory at present, and simply remark, first, that some of these compounds are almost certainly double salts, and, secondly, that in certain cases very simple formulæ are obtained if we suppose that V_2O_5, with the atomic structure $V_2O_2.O_3$, may replace WO_3 or MoO_3, while with the formula V_2O_5 it replaces P_2O_5. Other ternary series contain oxides of two types united to tungstic or molybdic oxide. Thus we have the general formulæ :—

$$m RO_3.n R'_2O_5.p R''_2O_3.r R'''_2O$$
$$m RO_3.n R''_2O_5.p R'_2O_3.r R'''_2O$$
$$m RO_3.n R'_2O_5.p R'_2O_3.r R'''_2O$$

in which R_2O_5 may be P_2O_5, V_2O_5, As_2O_5, or Sb_2O_5, perhaps also Nb_2O_5 and Tn_2O_5, and R_2O_3 may be B_2O_3, P_2O_3, V_2O_3, As_2O_3, Sb_2O_3. It will be seen that such compounds may be very numerous, especially if m, n, and p, may vary within wide limits. There is, however, at least one other group of ternary compounds reducible to the general formula—

$$m RO_3.n R'_2O_5.p R''O_2.r R'''_2O.$$

I have obtained a few salts belonging to such series. Finally, it seems probable that there is also a series embraced in the formula—

$$m RO_3.n R'_2O_3.p R''O_2.r R'''_2O,$$

but I have not yet obtained compounds of this type.

Quaternary compounds of various types appear to exist. An example of these is the following :—

$$60WO_3.3P_2O_5.V_2O_5.VO_2.18BaO+150H_2O.$$

This is almost certainly a double or triple salt, but still shows how five different oxides may exist in a single well-defined and beautifully crystallised compound. The general formula here would be—

$$m RO_3.n R'_2O_5.p R''_2O_5.q R'''O_2.r R'''_2O.$$

This possible number of combinations, if we take all the oxides not basic belonging to the four different types, and in addition give various values to m, n, p, and q, must be very great.

Besides the types which I have given above I have obtained others of an entirely different chatacter, and not containing either molybdenum or tungsten. To this class belong phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, the general formula being—

$$m R'_2O_5.n R''_2O_5.p R_2O.$$

The salts are often beautifully crystallised and well defined.

I reserve to myself the right to work in any part of this field of research, since the generalisations are exclusively my own; but at the same time I invite other

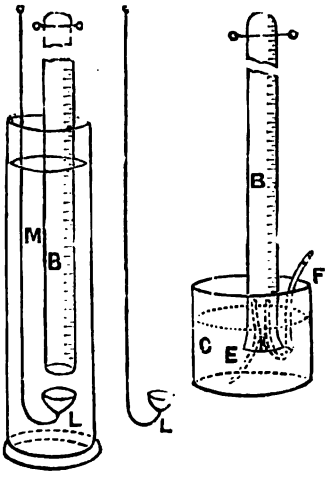
chemists to enter the same field, probably the widest which has been opened up in the domain of inorganic chemistry. The results which I have given above were communicated to the National Academy of Sciences at the April and November sessions of the year 1882, but some little time must elapse before I can fully complete another instalment of my work.—*Am. Chem. Journ.*

ON AN

APPARATUS FOR RAPID ANALYSIS OF GASES.

By A. A. BRENEMAN, S.B.

THE apparatus here described is designed for rapid analysis of gaseous mixtures where only a moderate degree of accuracy is required. It is possible nevertheless to secure very good results with it, if it be carefully handled, and if its known source of error be guarded against. As an example of the results that may be obtained with it, two analyses of air may be quoted which yielded respectively 21·04 per cent and 21·13 per cent by volume of oxygen instead of 20·96 per cent, which is probably a fair average for the most accurate analyses. The oxygen was absorbed by a solution of pyrogallic acid in caustic potash, in the proportion of 2 grms. of the solid acid to 5 c.c. of a solution of KHO (sticks) in twice its weight of water, and 10 c.c. of water were further added to the solution. The absorption of oxygen in each case occupied about twelve minutes. The excess of oxygen indicated is probably to be accounted for by the solution of part of the gaseous mixture in the water used for rinsing, but the error belongs to all absorption-methods of analysis where the gas is measured over water.



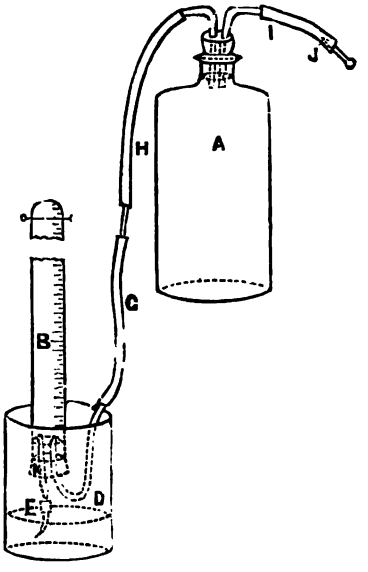
The apparatus and its use will be readily understood from the accompanying diagram. A is a bottle holding a litre or more. It is closed by a soft rubber stopper carrying two tubes, one of which communicates with a water air-pump, the other with the gas burette. After exhausting the bottle at the pump, the tube I is closed by the stopper: F G H is already closed by a bit of stirring rod, plugging the rubber tube G at F, and serving also as a valve. It is opened by simply pinching up a portion of the rubber tube about it, thus forming a channel around the plug. The gas burette B is closed by a rubber stopper K, carrying two tubes, one of which connects with A; the other carries a valve at E and a pointed tube of glass at its end.

The gas burette is filled with gas over the pneumatic trough C, the cork K being removed. It is then transferred by means of the deep spoon L to the measuring cylinder, the volume of the gas is noted with the existing temperature, the burette is again brought to the trough, K is inserted, and then by opening the valve F the level of water in the burette is brought to the inner surface of the cork K, the water passing into the exhaust bottle L. This bottle is used in the same way subsequently to receive all drainings and rinsing water from the burette.

The absorption liquids are introduced by bringing the point of the tube below E into the liquid and opening E; liquid rushes into the partially exhausted tube to replace the water previously withdrawn.

The burette is shaken to distribute the liquid over its sides, and more of the liquid is introduced as the absorption proceeds. When absorption is complete the liquid is withdrawn as before, the tube is rinsed with successive small quantities of water, and the gas finally measured again over water in the cylinder M.

The obvious errors of the apparatus are the entrance of air about the cork K, and separation of gases from the liquids used in the burette when the level of the liquid in the latter is reduced. A soft, well-fitting rubber stopper will remove the first objection, and as an additional precaution the mouth of the burette is kept below the surface of the water whenever it is not necessary to manipulate the burette. In practice the entrance of external air through leakage is inappreciable during the time of the analysis.



The second source of error is avoided by using such quantities of absorbing liquids that the diminution of pressure within the burette may be slight. During the time of greatest exhaustion, that is during the withdrawal of liquids, the current tends to carry minute bubbles that may separate downwards and into the bottle, and with a good vacuum (20·25 inches of mercury) in the latter, the time is too short to permit of any important volume of gas separating from the liquid.—*Journ. Am. Chem. Soc.*

EDWARD DAVY; A PIONEER OF THE ELECTRIC TELEGRAPH.*

EVERYONE who has acquired the slightest acquaintance with the history of science is well aware that many of the grandest ideas and discoveries that mark out new eras in

* Honour to whom honour is due! Edward Davy and the Electric Telegraph, 1836 to 1839, by J. J. Fahie. London: Office of the *Electrician*.

the advancement of the different branches of science have been conceived or worked out independently, and often contemporaneously, by different men, totally ignorant of each other's existence. In our own branch of science we at once call to mind the discovery of the composition of the atmosphere, of oxygen, and the composition of water; the stoichiometric equivalents of Richter and Wenzel and the atomic theory of Higgins and Dalton. In more recent times the discoveries in spectroscopy and many others in pure chemistry may be brought forward to confirm the point in question. This strange fact of the independence and frequently contemporaneity of similar ideas is exhibited in almost any branch of science we like to select, and consequently it is not to be wondered at if the just claims of many men to participate in the honour due to the thinker or experimenter who confers a lasting benefit upon mankind are often lost in oblivion.

There is at present alive and well, practising as a surgeon in Australia, an old gentleman named Edward Davy, who almost half a century ago conceived, and actually carried some of his ideas into effect, the germ—ay, and more than the germ—of what is now considered the wonder of the age, the electric telegraph, and who was on the very verge of giving to the world the Davy's system instead of what was accepted as the Cooke and Wheatstone system of telegraphy. What Davy's ideas were and what he accomplished that entitles him to an honourable recognition as one of the pioneers of the electric telegraph, considering the very crude notions held by even the most successful experimenters of that time, are simply amazing. His manuscripts which have recently been brought to light (thanks to the efforts of Mr. J. J. Fahie, of the Society of Telegraphic Engineers, and of Davy's nephew, Dr. H. Davy, of Exeter) show the wonderful grasp he had obtained of the principles of telegraphy. Sketching out in 1836, when the idea first occurred to him of employing electricity as a means of communication, his plans, he wrote,—"Let us suppose a number of copper wires, each covered with silk and varnished, to be laid underground, side by side, from London to Liverpool. For greater protection they may be enclosed in an iron pipe. If there be a small brass ball at each end of each wire, an electric spark applied to the ball at the London end of any of them might be drawn at the same instant from the corresponding ball at the Liverpool end." Such a plan as this, however, was not the one Davy recommended in practice. He devised means by which to employ the Voltaic current; the signals being indicated by forming the receiving ends of the wires into coils of from five to two hundred turns arranged in a row, in the magnetic meridian, and in each being suspended a sensitive magnetic needle carrying a letter marked upon it. The feeblest current, wrote Davy, would produce a deflection, but if from the great distance that the electricity had to travel it became too feeble its effect on the needles could be increased by multiplying the convolutions of the coils. Thus was his method rendered well nigh theoretically perfect, but among other devices that he conceived to render the signals perceptible was this—"a piece of soft iron may be surrounded by a helix of copper wire so as to form a temporary magnet which will attract and relinquish a small piece of iron carrying the signal letter at every make and break of the current"—and "instead of steel needles, coils of copper wire may be deflected in the neighbourhood of fixed magnets." Then followed the idea of diminishing the number of wires to be employed by using right and left deflections of the needles, until about the commencement of 1837 he had so perfected and improved his apparatus that he obtained permission from the Commissioners of Woods and Forests to lay down a mile of copper wire round the inner circle of the Regent's Park, with which he successfully experimented. About March of that year Davy heard of Prof. Wheatstone's experiments, and to secure his position he gave to Mr. Aikin, then the Secretary of the Society of Arts, a sealed packet containing the description of his invention. To his other improvements Davy designed what he called the "Electrical Renewer," or the instrument now known as the "Relay," and so rendered his system practicable. In May, 1837, when Cooke and Wheatstone made application for their first patent, Davy opposed it, and handed to the Solicitor-General a document containiug a full description of his apparatus. In this document he described the parts of his telegraph as—"1st. Signal and alarum arrangements. 2nd. Originating mechanism. 3rd. Conducting and continuing arrangements." To show how far his ideas and apparatus were in accord with those that have been or are now employed, the following extracts from this document will indicate. The signals and alarums "are effected by a number of galvanometer needles, and conducting wires, each of which terminates in a double coil which acts upon two needles. The form of the coil is that of the figure 8 (only the loops are made rectangular), and in each loop a magnetic needle is suspended. The whole is so arranged that all the needles point north and south. By means of pins or stops each needle is prevented from having its signal pole deflected except in one direction. It is then evident that if the electric current be passing in one direction the upper needle only, and if in the other direction, the lower needle only, will be deflected." For the conducting and continuing arrangements Davy stated that "the best mode of laying the conducting wires remains to be determined by experience on a large scale, and the localities through which they may have to be brought. Either they may be somewhat flattened between rollers, and bound together with interposed pieces of cloth, soaked in pitch or rosin, &c., the whole being enveloped with canvas tarred, or impregnated with melted caoutchouc and linseed oil, or the like; or they may be secured in a tube." "In the former case they would admit of being suspended in the air, from post to post, protected by lightning conductors." The principle of his electrical renewer was described thus:—"The principle of this contrivance is that, the total distance being divided into a number of shorter ones, there be a separate galvanic circuit for each, and that, at the termination of each length of wire, its current be made to produce a motion, which establishes a communication between a fresh source of electricity and the wire which extends through the next succeeding distance . . . ." "By this contrivance it is clear that there can be no physical limit to the distance to which electric currents may be carried, and, therefore, the expense of long distances will cease to be in an increased ratio to that of short ones." Among his "additional observations" in this document is indicated clearly the grasp he had obtained of telegraphy and its applications. "Portable Telegraphs.—Such a contrivance might occasionally be useful in warfare." "Marine Telegraphs.—Communications may be effected through or under the water by enclosing the conductors in ropes well coated or soaked, in an insulating and protecting varnish, as melted caoutchouc, &c. The ropes could then be sunk to a certain depth by weights and supported by small floats, or buoys. In connection with the rope we may have an air-tight and water-tight electrical renewing apparatus at each requisite interval."

In addition to all this theory and experiment Davy brought his system before the notice of the public; about the end of 1837 a working model was shown at the Belgrave Institution, London, and for eleven months of the succeeding year he publicly exhibited his telegraph in a room, rented for the purpose, in Exeter Hall. In the *Mechanics Magazine*, too, his arrangements were described by persons who had inspected the exhibit.

Towards the end of 1837 Davy conceived the idea of a recording telegraph, but owing to the opposition of Cooke and Wheatstone it was not until the middle of the next year that the specification was sealed. Professor Faraday, who was consulted at the time regarding the rival claims, considered the two inventions to be distinct.

That Davy and Cooke and Wheatstone were engaged working out similar ideas with regard to the needle telegraph, the following extract from Davy's statement, written about that time, will show, and to what extent his

claims deserve recognition:—"In May, 1837 Messrs. Cooke and Wheatstone applied for a patent to which I entered opposition, having provided myself with a written description of my inventions and prepared to attest it by the evidence of several confidential friends. This evidence will be partly direct and partly corroborative. . . . " The Solicitor-General at the time gave an opinion that the two inventions were different, and allowed the patent to pass, although time has since shown that they contained some of the clearest identities.

"My remedies for the injustice thus sustained are, that I may move a writ of *scire facias* to set aside and annul Messrs. Cooke and Co.'s patent, on the ground that the Crown was misled in granting it, or else, or after failing that, to act upon the invention so that they may bring an action for infringement, which I have ample grounds for defending, and the failure of which will *virtually* render their patent void."

Having accomplished so much for telegraphy Davy's foresight was not slow in showing him how numerous would be the advantages possessed by such a rapid means of communication—preventing accidents on the railways and facilitating rapid travelling. "The finger of the London correspondent is on the finger key; and, anon, in less time than he can remove it, the signal is already on the paper in Edinburgh, and almost as fast as he can touch one key after another in succession these signals are formed into words and intelligent sentences. These may either have private interpretation attached to them easily arranged between individuals, or thay may be translated according to rule by a clerk of the establishment, *supposing such an establishment thrown open to the public, like the Post Office*, on the principle that anyone might send a communication on paying some moderate fee, to be charged according to length."

Why, after having carried his ideas and experiment to such perfection, did Davy not succeed in getting his system taken up and worked into a practical form instead of allowing his rivals Cooke and Wheatstone a clear field seems a mystery. A few feeble attempts were made to get the Railway Companys to make a trial of his telegraph and to obtain the assistance of financiers, but just at that critical moment private affairs compelled him to leave Engtand for Australia in the spring of 1839, and now the world knows only of the Cooke and Wheatstone telegraph.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

STRONTIUM.

THE ratios which fix the atomic weight of strontium resemble in general terms those relating to barium, only they are fewer in number and represent a comparatively small amount of work. The early experiments of Stromeyer,† who measured the volume of CO_2 evolved from a known weight of strontium carbonate, are hardly available for the present discussion. So also we may exclude the determination by Salvétat,‡ who neglected to publish sufficient details.

Taking the ratio between strontium chloride and silver first in order, we have series of figures by Pelouze and by Dumas. Pelouze‖ employed the volumetric method already described under barium, and in two experiments obtained the subjoined results. In another column I append the ratio between $SrCl_2$ and 100 parts of silver:—

1·480 grms.	$SrCl_2$ = 2·014 grms.	Ag.	73·486
2·210 ,,	3·008 ,,		73·471

Mean 73·4781 ± 0·0050

Dumas,* by the same general method, made sets of experiments with three samples of chloride which had previously been fused in a current of dry hydrochloric acid. His results, expressed in the usual way, are as follows:—

Series A.

3·137 grms.	$SrCl_2$ = 4·280	Ag.	Ratio 73·2944
1·982 ,,	2·705 ,,		73·2717
3·041 ,,	4·142 ,,		73·4186
3·099 ,,	4·219 ,,		73·4534

Mean 73·3595 ± 0·0303

Series B.

3·356 grms.	$SrCl_2$ = 4·574	Ag.	Ratio 73·3713
6·3645 ,,	8·667 ,,		73·4327
7·131 ,,	9·712 ,,		73·4246

Mean 73·4095 ± 0·0130

Series C.

7·213 grms.	$SrCl_2$ = 9·811	Ag.	Ratio 73·5195
2·206 ,,	3·006 ,,		73·3866
4·268 ,,	5·816 ,,		73·5529
4·018 ,,	5·477 ,,		73·3613

Mean 73·4551 ± 0·0321

Combining, we have:—

Pelouze	73·4781 ±	0·0050
Dumas, A	73·3595	0·0303
,, B	73·4095	0·0130
,, C	73·4551	0·0321
General mean ..	73·4655 ±	0·0046

The foregoing figures apply to anhydrous strontium chloride. The ratio between silver and the crystallised salt, $SrCl_2.6H_2O$, has also been determined in two series of experiments by Marignac.† Five grms. of salt were used in each estimation, and, in the second series, the percentage of water was first determined. The quantities of the salt corresponding to 100 parts of silver are given in the last column:—

Series A.

5 grms.	$SrCl_2.6H_2O$ = 4·0515 grms.	Ag.	123·411
,,	4·0495 ,,		123·472
,,	4·0505 ,,		123·442

Mean 123·442 ± 0·012

Series B.

5 grms.	$SrCl_2.6H_2O$ = 4·0490 grms.	Ag.	123·487
,,	4·0500 ,,		123·457
,,	4·0490 ,,		123·487

Mean 123·477 ± 0·007

General mean of both series 123·470 ± 0·006

In the same paper Marignac gives two sets of determinations of the percentage of water in crystallised strontium chloride. Tne first set, corresponding to "B" above, comes out thus:—

40·556
40·568
40·566

Mean 40·563 ± 0·0024

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Schweigg. Journ.*, 19, 228. 1816.
‡ *Comptes Rendus*, 17, 318. 1843.
‖ *Comptes Rendus*, 20, 1047. 1845.

* *Ann. Chim. Phys.* (3), 55, 29. 1859. *Ann. Chem. Pharm.*, 113, 34.
† *Journ. f. Prakt. Chem.*, 74, 216. 1858

In the second set ten grms. of salt were taken at a time and the following percentages were found:—

40·58
40·59
40·58

Mean 40·583 ± 0·0020

General mean, from both series 40·575 ± 0·0015

The chloride used in the series of estimations last given was subsequently employed for ascertaining the ratio between it and the sulphate. Converted directly into sulphate, 100 parts of chloride yield the quantities given in the third column:—

5·942 grms.	$SrCl_2$ gave	6·887 $SrSO_4$.	115·932
5·941	,,	6·8855 ,,	115·949
5·942	,,	6·884 ,,	115·927

Mean 115·936 ± 0·004

Now, to sum up the ratios and calculate the atomic weight of strontium:—

(1.) Ag :	$SrCl_2$	:: 100 :	73·4655 ± 0·0046
(2.) Ag :	$SrCl_2.6H_2O$	:: 100 :	123·470 0·006
(3.) Per cent of H_2O in $SrCl_2.6H_2O$,			40·575 0·0015
(4.) $SrCl_2$:	$SrSO_4$	:: 100 :	115·936 0·004

We have now the molecular weight of $SrCl_2$, as follows:—

From (1)	$SrCl_2$ =	158·208 ± 0·017
From (2)	,, =	158·113 0·034
From (3)	,, =	157·852 0·032
General mean..	,, =	158·124 ± 0·014

And for the atomic weight of strontium itself we have two values as follows:—

1. From mol. wt. of $SrCl_2$..	Sr =	87·384 ± 0·032
2. From (4)	,, =	86·765 0·244
General mean.. ..	,, =	87·374 ± 0·032

If O=16, then Sr=87·575.

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING AUGUST 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, September 7th, 1883.

SIR,—We beg to submit to you a statement of the results of our examination of the 182 samples of water collected by us during the month of August, at the times and places indicated, from the mains of the seven London companies taking their supply from the Thames and the Lea; together with some remarks on the character of the supply during the preceding month.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from August 1st to August 31st inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 182 samples of water submitted to examination, the whole, excepting three samples, one of which was recorded as "very slightly turbid" and two as "slightly turbid," were clear, bright, and well filtered. In respect to aëration, and freedom from colour and excess of organic matter, they have maintained the excellent character exhibited now for many months past.

In Dr. Frankland's report to the Registrar-General, on the character of the waters supplied to the Metropolis during the month of July, it is stated that "The Thames water supplied by the Chelsea, &c., Companies was *again, for River water, unusually* free from organic matter;" and then, a little further on, that "The deep well water distributed by the Kent, &c., Companies was of its *usual* excellent quality for drinking, and in freedom from organic matters surpassed any of the River waters;" this mode of disparaging river-water in an official, and presumedly impartial report, seeming to be thought by the writer a fitting way of declaring his individual dissent from the conclusions in favour of river-water come to by Parliamentary and Royal Commissions, notwithstanding his own adverse evidence.

In the same July report to the Registrar-General, it is stated that the so-called "organic impurity" of the river-derived supply of London is from two to three times as great as that present in the well-water supply of the Kent Company, selected as a standard. It is not, however, pointed out, *per contra*, that the so-called "previous sewage contamination" of the standard well-water is from two to nearly three times as great as that of the river-derived water; although the reporter's own figures, establishing alike the two results, are as authoritative in the one case as in the other.*

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 3, 1883.

Volumetric Determination of Mercury.—A. Haswell.—The solutions required are:—Permanganate of known efficacy; ferrous sulphate acidified with sulphuric acid and standardised according to the permanganate employed, and a moderately concentrated solution of stannic chloride, containing neither free chlorine nor

* It is not meant seriously to imply that the well-water is rendered unwholesome by reason of its unquestionable excess of what has been called by Dr. Frankland "previous sewage contamination," any more than that the river-derived water is rendered unwholesome by reason of its unquestioned excess of what he calls "Organic impurity." Only, if at a period of general anxiety with respect to the threatenings of an epidemic outbreak, it is justifiable, as a means of exciting prejudice and alarm, to measure river-water by a well-water standard, and persistently to stigmatise a characteristic constituent of the river-water supplied to some four millions of people by a nasty-sounding name, it must be equally justifiable (?), with the same worthy object, to measure well-water by a river-water standard, and to stigmatise a characteristic constituent of the well-water supplied to less than half a million of people, by a similarly nasty-sounding name, also the offspring of Dr. Frankland's happy invention.

stannous oxide. It is prepared by dissolving pure tin in hydrochloric acid with the addition of potassium chlorate, boiling the solution until all chlorine has evaporated and precipitating with sodium carbonate. The filtered precipitate dissolved in hydrochloric acid should be reddened for at least three hours by a single drop of permanganate. In the execution of the process the solution of mercuric chloride, measured off with the pipette, is mixed with a known excess of the ferrous sulphate, and supersaturated with pure potassa. The blackish brown precipitate thus formed is digested for a few seconds, shaking the glass, acidified then with sulphuric acid of a moderate strength, and agitated till the permanent precipitate of mercurous chloride appears perfectly white. The excess of ferrous oxide is then at once oxidised with permanganate without filtration. This process may be regarded as complete when the milk-white liquid takes a peach-blossom colour. For the titration of the mercury a few drops of the stannic chloride are added, and permanganate is run in till the liquid is coloured a permanent red. The liquid becomes gradually clearer during the addition of the permanganate, but it does not always become quite limpid.

Determination of Glycerin in Soap Lyes.—M. Flemming.—The author neutralises 25 c.c. with dilute sulphuric acid, precipitates the fatty acids present with a minimum of milk of lime, and concentrates as far as possible on the water-bath. The residual mass is extracted with alcohol to which one-third its volume of ether has been added (until a few drops of the filtrate give not a deep blue solution, but a pale blue precipitate with copper sulphate and potassa free from carbonic acid), the solution is evaporated, the residue dried at 115°, weighed, incinerated, and the weight of the ash deducted.

Determination of the Total Carbon in Crude Iron and Steel.—H. F. Starr.—This method is not new.

Determination of Alkaloids in Nux Vomica.—W. R. Dunstan and F. W. Short.—From the *Pharmaceutical Journal.*

Sodium Nitro-prusside as a Reagent for Kreatinine and Acetone in Urine.—F. Hofmeister.—Solutions of kreatinine, if mixed with a weak aqueous solution of sodium nitro-prusside and soda, give a more or less intense red colouration, which on the addition of an acid passes into a greenish yellow. The ordinary ingredients of urine do not interfere, but acetone gives a similar change of colour. Indol gives also a brownish red colour, but on the addition of acetic acid it changes to a fine azure blue. Acetone should be sought for in the distillate of urine.

Conjugated Phosphoric Acid in Urine.—MM. Lépine and Eymonnet.—The authors precipitate with magnesia mixture, evaporate the filtrate to dryness, and fuse the residue with saltpetre. In the nitric solution of the melt the newly-formed phosphoric acid is determined by the ordinary procedures. It is probably derived from phosphoro-glyceric acid.

Oxy-hæmoglobine of the Pig.—J. Otto.—The author gives a method for obtaining this principle from the blood of swine.

The Ptomaines.—MM. Dragendorff and Gräbner.—This paper is not adapted for abstraction.

MISCELLANEOUS.

Appointment.—On Tuesday last, Mr. F. J. M. Page, B.Sc., F.C.S., was elected Demonstrator of Practical Chemistry at the London Hospital Medical College.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Southport Meeting of the British Association :—

President.—J. H. Gladstone, Ph.D., F.R.S.

Vice-Presidents.—Prof. J. Dewar, M.A., F.R.S.; A. G. Vernon Harcourt, M.A., F.R.S.; Prof. G. D. Liveing, M.A., F.R.S.; Prof. H. E. Roscoe, Ph.D., LL.D., F.R.S.; W. Weldon, F.R.S.; Prof. A. W. Williamson, Ph.D., LL.D., F.R.S.

Secretaries.—Prof. P. P. Bedson, D.Sc. (Recorder); H. B. Dixon, M.A.; H. Forster Morley, M.A., D.Sc.

Committee.—A. H. Allen; Prof. J. Attfield, F.R.S.; W. Lant Carpenter, B.A., B.Sc.; T. Fairley; R. Meldola; E. K. Muspratt; Prof. Chandler Roberts, F.R.S.; G. Ward; Prof. W. Carleton Williams; C. R. A. Wright, D.Sc., F.R.S.

The Papers brought before the Section were as follows:—

Profs. Liveing and Dewar—On Sun Spots and the Chemical Elements in the Sun.

R. Meldola—Colouring matters of the Diazo-group.

Prof. R. B. Warder—Suggestion for computing the Speed of Chemical Reation.

T. M. Morgan, B Sc.—Ortho-amido-cinnamic Acid.

T. M. Morgan, B.Sc.—On the Preparation of Cinnamic Acid.

P. M. Parsons—On Manganese Bronze.

H. B. Dixon—Report of Committee on Chemical Nomenclature.

Prof. W. N. Hartley—Report of Committee on the Ultra-violet Spark-spectra.

H. B. Dixon—Explosion of Carbonic Oxide Gas.—A Demonstration.

Prof. A. W. Williamson—Chemical views on the Constitution of Matter.

Prof. Dewar and A. Scott—On the Atomic Weight of Manganese, and the Molecular Weights of the Compound Ammonias.

Dr. J. H. Gladstone—The Length of the Prismatic Spectrum as a Test of Chemical Purity.

Prof. W. Ramsay—The Application of Bisulphide of Carbon to the Scouring of Wool.

W. Lant Carpenter—The Conversion of Oleic Acid into Palmitic Acid, and Fusions with Caustic Alkalies at High Temperatures.

Rev. W. A. Irving—The Action of Sunlight on Phosphorus Trioxide.

Prof. Dewar.—On Liquid Marsh Gas.

Prof. Dewar.—On Critical Points and Pressures and their relation to Atomic Volumes.

G. Johnstone Stoney.—On the relation between Chemical Constitution and Crystalline Form.

Dr. J. H. Gladstone and A. H. Tribe.—The Electrolysis of dilute Sulphuric Acid in Secondary Batteries.

Prof. W. Chandler Roberts.—Mobility of Gold and Silver in molten Lead.

E. C. C. Stanford.—Algine, a new substance obtained from sea weed.

Watson Smith.—Processes for the coking of coal with recovery of the bye-products.

Prof. H. E. Armstrong.—Report on Isomeric Naphthalene derivatives.

H. Brereton Baker.—On the alleged direct union of Hydrogen and Nitrogen.

Profs. Friedel and Crafts.—Decomposition of Hydrocarbons by means of Aluminium Chloride.

R. Warington.—On the Nitrates in Soil.

M. Whitley Williams.—A description of a simplified Thermostat.

M. Whitley Williams.—An account of some experiments on Asbestos.

J. A. Wanklyn and A. Fox.—On the constitution of natural fats.

J. A. Wanklyn.—On the employment of limed coal in gas-making.

W. Thomson.—On methods of demonstrating that transparent glass is crystalline.

W. Thomson.—On molecular movements in the vicinity of thin iron plates.

W. Lant Carpenter.—On the teaching of Chemistry in Elementary Schools.

J. Boyd Kinnear.—New method for Disinfecting Sewage, and recovering Ammonia from it.

THE CHEMICAL NEWS.

Vol. XLVIII. No. 1245.

ON A REACTION BETWEEN MERCURIC CYANIDE AND SILVER NITRATE IN THE PRESENCE OF AMMONIA.

By C. L. BLOXAM.

Although ammonia does not precipitate a solution of mercuric cyanide or silver nitrate when separate, a mixture of the two solutions gives a copious opaque precipitate with ammonia.

A salt having the formula $AgNO_3,HgCy_2,2Aq$, was obtained by Wöhler, and is described in "Gmelin's Handbook" (viii., 33), where it is stated that "alkalies throw down cyanide of silver," but if the formula represent the salt correctly, it is not intelligible that this should be the case.

On mixing solutions of the two salts which are neutral to blue litmus, the mixture is found distinctly acid, indicating the production of mercuric nitrate, which has an acid reaction. If the solutions are moderately strong, the mixture presents an excellent instance of supersaturation, remaining clear until stirred with a glass rod, when it becomes a pasty mass of fine needles. Under the microscope the sudden crystallisation when touched with a glass rod presents a very beautiful appearance. The double salt is remarkable for forming tufts of needles radiating from a centre, and deposited first in sharp thin lines, gradually developing from the end next the centre of the tuft into thick brilliant prisms resembling nitre.

A solution of mercuric nitrate (prepared by decomposing mercuric chloride with silver nitrate) dissolves precipitated silver cyanide very readily on warming, and deposits the characteristic needles of the double salt on cooling. The same result was obtained with the solution of (so-called) basic mercuric nitrate prepared by saturating diluted nitric acid with mercuric oxide. Synthesis, therefore, is not opposed to the view that the salt contains mercuric nitrate and silver cyanide. On the other hand, hydrocyanic acid precipitates silver cyanide from the aqueous solution of the salt, indicating the presence of silver nitrate. The salt, which had been well pressed in filter-paper, lost 8·29 per cent at 100°. The formula requires 7·86. Wöhler gives 7·6, and Johnstone (by difference) 7·93.

A strong solution of silver nitrate was treated with dilute ammonia till the precipitate was just re-dissolved. Solution of mercuric cyanide was then added by degrees, with constant stirring. Much ammonia was set free, and an opaque white precipitate (A) was produced. After a certain quantity of mercuric cyanide had been added, a silky crystalline precipitate separated; this portion (B) was collected apart. The filtrate gave another silky precipitate (C) of somewhat different appearance. The filtrate from this contained a very small quantity of silver, but much mercury and cyanogen. Precipitate A decomposed with a slight explosion when heated. Qualitative analysis indicated much silver, mercury, and cyanogen, with a little nitric acid and ammonia.

After a week's exposure to air dried by sulphuric acid, it was found to lose 0·82 per cent when heated to 100°. The salt having become slightly discoloured, this loss is probably due to decomposition, and the salt is anhydrous.

14·6 grains treated with strong hydrochloric acid, evolved much HCN, and, after evaporation and fusion, left 8·72 of silver chloride, giving 44·93 per cent of silver.

22·78 grains, decomposed by hydrochloric acid, the siver chloride washed with hot water, the mercury in the filtrate precipitated by H_2S, gave 36·72 per cent of mercury, and 44·79 per cent of silver.

18·60 grains, treated in the same way, gave 45·23 per cent of silver and 36·13 per cent of mercury, the silver chloride having retained some of the mercuric chloride.

14·57 grains were distilled with a strong solution of potash into a receiver containing HCl. The ammonium chloride obtained weighed 0·15, corresponding to 0·32 per cent of ammonia, which is probably carried down by the precipitate and not essential to its composition.

10·57 grains digested with yellow ammonium sulphide, to convert the cyanogen into ammonium sulphocyanide, the filtrate evaporated, mixed with silver nitrate and excess of nitric acid, gave a precipitate which, when strongly ignited, gave 6·13 grains silver, corresponding to 13·95 per cent of cyanogen.

Finding that the decomposition of the salt by potash was incomplete, since the residue of mixed oxides deflagrated when heated, a portion was digested with KHS and sulphur, with a view to the determination of the nitric acid. After being heated till no more ammonium sulphide was evolved, the solution was filtered from the sulphides of silver and mercury, mixed with caustic potash, and allowed to remain for about twenty hours in contact with sheet aluminium in a retort connected with a receiver containing hydrochloric acid, into which it was eventually distilled; the distillate gave 0·34 grain of ammonium chloride, corresponding to 0·394 of NO_3 or 2·11 per cent, which appears to me too small a quantity to be regarded as an essential constituent.

Precipitate B exploded somewhat less violently than A. After being dried over sulphuric acid, it lost only 1·13 per cent at 100°. Analysed in the same manner as A, it gave in two determinations, 45·54 and 45·68 per cent of silver, and 36·08 and 36·29 per cent of mercury, showing that its composition was the same as that of A.

If the NH_3 and NO_3 be regarded as impurities carried down by the precipitate, and their sum be deducted from the weight of the precipitate, the results agree closely with those required by the formula $2HgO,HgCy_2,7AgCy$:—

	Calculated.	Found.
Ag_7	46·60	46·43
Hg_3	36·99	37·03
Cy_9	14·42	14·29

It would be more satisfactory to determine the cyanogen by another method before finally accepting the formula; this I am prevented from doing at present by the termination of my vacation.

Precipitate C was silver cyanide. When decomposed by hydrochloric acid it gave AgCl corresponding to 79·71 per cent of silver; the pure cyanide contains 80·6. The filtrate gave a dark tinge, but no precipitate, with H_2S.

The above experiments appear to me to justify the belief that mercuric cyanide and silver nitrate undergo, at least partially, a mutual decompostion into silver cyanide and mercuric nitrate, and that the precipitate formed in the presence of ammonia is composed of silver cyanide and mercuric oxycyanide.

King's College, London.
Sept. 25th, 1883.

Enrichment of the Soil in Nitrogen.—M. Agathon.—In 1868, a certain portion of the experimental fields at Grignon, was found to contain 2·02 to 2·04 grms. nitrogen per kilo. In the years 1870 to 1882 inclusive, it produced 4 crops of wheat, 2 of oats, 1 of tares and peas, 1 of beets, and 4 (continuously) of lucerne, receiving as manure 104.000 kilos. farm-yard manure. The total crops had certainly removed more nitrogen than this quantity of manure could compensate, yet, in the autumn of 1882, the soil was found to contain 2·45 to 2·56 grms. nitrogen per kilo. The author ascribes this enrichment to the four years' cropping with lucerne.—*Biedermann's Centralblatt.*

PROFESSOR HOFMANN'S ADDRESS AT THE UNVEILING OF THE LIEBIG MEMORIAL AT MUNICH, AUGUST 6th.

After a few introductory remarks, Professor Hofmann went on to say:—

"Let us, though with hurried steps, retrace the course of Liebig's life: the outward incidents of a life devoted to Science are soon told. Justus Liebig was born on May 13, 1803, in Darmstadt; his parents were of the middle class, his father being a dyer and cloth merchant, and it was without doubt the many opportunities the boy enjoyed in his father's factory of watching the processes of dyeing that early gave him an interest in Chemistry; at least, we find him, at an age at which few have decided on or even thought of their like-work, zealously devoting himself to the preliminary studies of that science which was soon to occupy his whole attention. At that time chemistry held by no means the prominent position in our universities that it does to-day; we must therefore not be surprised that, after a brief residence at Bonn and Erlangen, Liebig turned his eyes to Paris, at that time the centre of attraction to disciples of science. By a happy combination of circumstances Liebig's wish to continue his studies under the famed masters of the French capital was quickly gratified. The spirit of discovery was early roused in him, and the first-fruits were such as showed that he possessed exceptional talents in that direction. Although through the generosity of the then Grand Duke of Hesse his stay in Paris was prolonged, still his dearest wish would have been unfulfilled had he not fortunately made the acquaintance of Alexander von Humboldt, through whose powerful influence the doors of the French laboratories were opened to the young chemist as if by a magic wand. With his usual keen insight the famous German explorer recognised at once the great promise of his young fellow-countryman, and from that hour was his protecting friend: quickly his *protégé* gave proof how justly that protection was bestowed.

At the commencement of the century Howard and Brugnatelli had discovered these explosive compounds of mercury and other metals, which are still used in percussion caps and for similar purposes. The chemical composition of these compounds was at that time unknown, as chemists had been deterred from examining them by several serious explosions; but, in conjunction with Gay-Lussac, in whose laboratory he was working, Liebig undertook their investigation, and succeeded at length in ascertaining the nature of these mysterious bodies, with the result of placing the chemistry of explosives on a firmer foundation, and opening up new fields of research.

This work, accomplished under the auspices of Gay-Lussac, won for Liebig an established place in Science; but it had another result, which he never ceased to regard as the most fortunate event of his life. Shortly after Liebig's research was published, Frederich Wöhler, a young chemist of nearly the same age, arrived at results in an allied branch of investigation, which he believed to be at variance with those of Liebig. The consequence was a keen controversy, in which Liebig was beaten. This encounter in the same field of work—to smaller souls so oft a source of bitterness or lasting hate—only drew these young men together, and formed the commencement of a life-long friendship, which proved a source of pleasure to themselves and of the richest service to science. After remaining in Paris for two years, Liebig returned to Germany, where, on the recommendation of Humboldt, he was, at the age of 23, appointed first extraordinary, and soon after ordinary, Professor of Chemistry at Giessen. It was there, in the small University town on the banks of the Lahn, that Liebig earned his world-wide fame.

In order to understand aright Liebig's triumphs in discovery, we must go back to the third decade of the century. Thanks to the pioneer work of Lavoisier and his contemporaries at the end of last century, and to the comprehensive researches of Berzelius in Sweden, Davy in England, and Gay-Lussac in France, at the beginning of the present, chemistry had acquired a philosophic foundation: what was known in this connection was due almost exclusively to the study of inorganic substances. Then for the first time attention was directed to the constituents of animal and vegetable products; thus a wide field of investigation was opened up, which Liebig was not slow to take possession of. His efforts were rewarded by a long series of brilliant results, which enrich the history of organic chemistry: some achieved by himself alone, others along with his friend Wöhler, or with the assistance of enthusiastic disciples, who were not slow to enrol themselves under the banner of the Great Master. The extensive field was explored in all directions; no corner, however remote or obscure, escaped the keen glance of the untiring explorer.

I might here endeavour to enumerate the results of Liebig's researches in the province of organic chemistry, and show their many-sidedness and number; give you examples of the acuteness and accuracy of his observations; his unprejudiced interpretation of the results obtained; the forcible logical sequence of his experiments, and the finely-forged chain of his evidence: in this connection I would naturally also show to you the manner in which the separate experiments are woven into one great scheme, in which it would not be difficult to recognise the basis on which, by the united work of investigators of all lands, the glorious superstructure of modern organic chemistry has been raised: but such a detailed account of Liebig's life-work would require hours instead of the few minutes at my disposal. I am therefore in a position only to sketch its principal features in brief outline.

To the conqueror who has won for us a new province of science belongs our greatest admiration, but, in addition, deep-felt gratitude is aroused when we find that he has supplied us also with weapons wherewith we hope not merely to retain possession of his conquest, but also to make new ones for ourselves. This Liebig has done. Not content himself to question Nature, he has put others in a position to do the same, making it his constant endeavour to simplify and perfect the means of doing so. It is to him we owe these efficacious methods for the analysis of organic substances, which are still in constant use, and seem likely for all time to meet the requirements of experimenters. Thus the fame of Liebig is assured, for, although his own short work-day is over, he still lives on, taking part in the work of his successors and sharing their triumphs.

While speaking of the important aids to research with which he has enriched science, we naturally call to mind that he was the first to give methodical instruction in the art of investigation. The experimental method of teaching which is to-day practised with such brilliant results in our German universities, is in form and essence the same as that which Liebig introduced more than half a century ago; and though we now possess appliances far superior to those at Liebig's disposal, we must not forget that these splendid temples of science which to-day form part of all our schools, have as their prototype that modest laboratory which he founded on the Lahn, and to which he for many years attracted the flower of the chemists of all lands.

Had the history of chemistry no other service of Liebig to chronicle than that he had thus assisted her growth, his name would still be inscribed on its pages in golden letters. Our fatherland has had at all times many distinguished men whose services to science it has always been ready to recognise, and we would not be standing to-day on the steps of Liebig's memorial had he not done so much to enlarge the bounds of chemistry. It was a distinctive trait in his character that he, though a student of pure science, still found his greatest satisfaction in being able to utilise his discoveries for the purposes of practical life. Thus it came to pass that his scientific work included a number of branches of industry based on

chemical principles. That portion relating to explosives has been already referred to; in a similar way his investigations on Fats, Acetic Acid, and Potassium Ferrocyanide, have had beneficial results. Lastly, the method proposed by him for the preparation of potassium cyanide, so largely employed in electro-plating, has had an indirect, but still an unmistakable, influence on the development of that industry.

However important may have been the influence of Liebig's researches on the above industries, it sinks into insignificance before the results of his work in two branches of study which appeal to the sympathy of all men. In the book which the genius on the pedestal before you holds in his hand we find inscribed after chemistry, agriculture and physiology. It is indeed in the department of agriculture that Liebig has done most for the welfare of his fellow-men, and it may well surprise us that it was reserved for the youngest of the sciences to effect, in the oldest of all industries, reforms, —nay, well-nigh a complete revolution,—and that this should be accomplished by one who had never walked behind a plough, nor possessed a single acre. For thousands of years had men sown and reaped without gaining any clear knowledge of the laws of the growth of plants. Experience, it is true, left no doubt as to the efficacy of manure, but with regard to the part it played in nourishing the plant the most daring hypotheses were common. It is only with difficulty that we can now realise the condition of agriculture when Liebig first attacked its problems from their chemical side. Inasmuch as he has made known the true nature of vegetable life, and the real action of manures, he has given the farmer the key to the most difficult problems. Scales fell from his eyes when he realised what constituents of the growing plant came from the air, and what from the soil, and in what way the loss to the soil must be repaired if he would retain the fertility of his fields. Here the question presented itself, Was this reparation to be made only by animal manure? and the answer came most clearly and decisively in the wide development of the various artificial manure industries. The manufacture of chemical substitutes for animal manure, which in a short time assumed enormous proportions, is thus entirely the result of Liebig's work. Thus agriculture, no longer to be classed as an art, entered the circle of the sciences, and it is one of Liebig's most powerful claims to fame that he inaugurated a new era in her history.

The food of animals is in the last instance the plant, and since the end of all husbandry is the feeding of the animal, it was only natural that he who had laid bare the development of the plant should also investigate the changes the plant undergoes in the body of the animal. Such a research promised success only to him who succeeded in bringing into the field of discussion all the conditions of animal life. This giant task had no terrors for Liebig's untiring energy, and we have to thank his acuteness and perseverance for a series of investigations on the constituents of the bodies of animals and the processes which take place in them—such as no other chemist can boast of.

His researches proved what formerly was a matter of conjecture, that the body of the animal is fore-prepared in the plant. The dependence of animal life on plant life is no longer doubtful, and the true appreciation of the life-conditions of animals and plants in their mutual relations enables us to recognise the course of nature in all its admirable simplicity. The expert calls to mind Liebig's long-continued researches on the food change in animals; on the formation of flesh and fat; on the functions of the different food materials which allowed him to divide them into "*plastische und respiratorische nahrung*": and if much to-day appears different to physiologists than it did to the investigator, who a quarter of a century ago first let a flood of chemical light into the darkness which hid the processes of life from view, still all, even those who have extended and improved his views, readily and cheerfully admit that they are, so to speak, standing on his shoulders. Just as Liebig's researches on plants proved of service to man far beyond the narrow bounds of science, so his studies in animal chemistry at once were turned to meet the requirements of life. In fact, scarcely had Liebig by his comprehensive research on flesh devised a simple process for separating and preserving the valuable constituents of meat, than a new industry sprang up with the object of turning to practical account this new achievement of science: and now for many years Europe has enjoyed the rich stores of food existing in another hemisphere, and this form of food has in a short space of time spread itself over the world, and attained a universal distribution similar to that of tea and coffee. Need I remind you also how Liebig, by his investigations on milk, was roused to the endeavour to provide a substitute for human milk, and so to render good service to the coming generations?

Liebig was now at the height of his fame, but his life was to undergo a change which turned his activity in a new direction. At this time Maximillian II. set himself the task of raising to the proud position of the centre of German science this town (Munich), which for many generations had been the home of German Art. One of the first appointments that was made was Liebig's. From the list of famous men collected on the Isar, his name could not be spared; but he was not easily moved. He clung lovingly to the low position in which he had accomplished such great things; but the personal wish of the King effected what the high station alone failed to do.

In this assembly it is hardly necessary to point out the comprehensive activity of Liebig in his new position, and the influence he exercised on the development of education, agriculture, and various industries; how he, as formerly, surrounded himself with an enthusiastic circle of disciples, and with his own hands created the famous School of Chemistry, which at this time flourishes in Munich under his worthy successor. It would ill become a stranger to speak here of Liebig's Munich days; let me, however, add that he never ceased to congratulate himself on being in a position to spend so happily the close of his life.

I must, before finishing the memorial wreath which I have to lay on the steps of his monument, interweave a few leaves bearing on the noble character of the man, but it is with considerable hesitation that I do so in the presence of so many who can boast of personal intercourse with Liebig up to the day of his death. Even, however, to me who must go back a quarter of a century to the time I spent in Liebig's neighbourhood, the memory of his noble character comes back with irresistible force.

Mind and soul strove in his happily balanced nature for the front rank; no sooner was one roused to admiration by his keen intellect, than the next moment one's deepest feelings were stirred by the heart of the man beating for all that was great and good. Happy the friend who had cast anchor in that deep heart! How Liebig regarded friendship has been recently told us by Wöhler, the companion of his youth. How many of us have experienced his steady fidelity to his friends, his never-tiring sympathy, his cheerful helpfulness! What a friend Liebig was has not reached the ears of the world, but the recollection lies hid in many thankful hearts. As in great things, so in small. The same noble principles which had served as his guides in investigation—his incorruptible love of truth —his unerring judgment—the same noble traits that rejoiced his friends—the nobleness of his thoughts—his active goodness of heart and his modest benevolence—were to be found also in his quiet everyday intercourse with his fellow-men. Hence came the irresistible charm which Liebig possessed on all sides.

He who dwells on this rich life finds fit expression for his thoughts in Hamlet's words—

> He was a man, take him for all in all,
> I shall not look upon his like again.

INCOMBUSTIBLE PAPER AND COLOURS.

At the Séance of the Société d'Encouragement pour l'Industrie Nationale on the 27th July of this year, M. G. Meyer submitted to the examination of the Society the results of his new experiments with his incombustible paper and colours. The admirable manner in which these materials could resist a high temperature was illustrated by rolls of the paper, printed with diverse colours; one half of the roll having been exposed for four hours to the heat of a muffle furnace. On a comparison of the two halves, that which had been subjected to the heat of the furnace had lost nothing of its flexibility, or the colours of their brilliancy.

The value of this invention of M. Meyer's has the advantage that the materials cost not much more than the paper, colours, ink, &c., generally employed, so that important documents, scenery for theatres, and wall-paper may be made, so as to resist a heat sufficient to melt glass, almost as cheaply as the articles now employed.

A sample of this paper with a printed design, which we have had the pleasure of examining, heated for a short time to redness in an air-gas burner, the design appeared almost as bright as before the operation, with but a slight alteration of the texture of the paper, and no loss of flexibility or toughness.

SEPARATION OF GALLIUM FROM TITANIUM.

By LECOQ DE BOISBAUDRAN.

The author indicates five methods, of which the one most generally applicable is founded upon the action of boiling potassa.

1. The titano-gallic solution is treated with a small excess of potassa and boiled for some minutes. The flocky precipitate collects quickly and filters without difficulty; after washing with slightly alkaline water it retains merely small traces of gallium, which are removed by re-dissolving in the cold with dilute hydrochloric acid, and repeating the treatment with potassa. The process succeeds equally well if we set out either with the product of the solution of titanium tetrachloride in dilute hydrochloric acid, or with the liquid obtained on dissolving in dilute hydrochloric or sulphuric acid, titanic acid previously precipitated by potassa, or, lastly, from a sulphate soluble in the cold, the result of treating the titanic compounds with boiling sulphuric acid or melting ammonium bisulphate.

2. The galliferous titanic acid is heated with sulphuric acid. The mass, when cold, is dissolved in an excess of water, and then boiled. The precipitate contains the greater part of the titanic acid, though a notable part remains in the solution. This is evaporated until the greater part of the sulphuric acid is expelled, though a little of this acid should remain in the free state. It is let cool, re-dissolved in water and boiled again. The matter resolves itself gradually into two fractions: A, the precipitate containing almost all the titanium and slight traces of gallium; B, the liquid containing the gallium with a little titanium. A is re-dissolved in hot sulphuric acid and the solution treated as has just been described, when the traces of gallium are easily removed. But the liquid B retains still a small quantity of titanic acid, because the expulsion of the free sulphuric acid cannot be carried beyond a certain limit without risking the formation of gallium sub-sulphate on boiling the dilute liquid. It is true that much of this gallium sub-sulphate redissolves during the cooling of the unfiltered liquid. The more or less complete precipitation of the titanic acid depends on the proportion of gallium oxide contained in the mixture. The last portions of the titanic acid are removed by potassa according to the directions given under method 1. In spite of this little analytical complication, the precipitation of titanium by boiling very dilute solutions may serve if only to concentrate rapidly in a small bulk small quantities of gallium mixed with much titanium. If the matter to be analysed is not readily attacked by boiling sulphuric acid it is fused with ammonium bisulphate. The product of this operation is taken up in water, boiled after the addition of aquaregia in order to destroy ammoniacal salts, and then boiled until sulphuric vapours appear. The remaining treatment is then the same as described above.

3. The hydrochloric or sulphuric solution of galliferous titanic acid is mixed with arsenious acid and an excess of acid ammonium acetate. The liquid is treated with hydrogen sulphide immediately after the introduction of the ammonium acetate. Sometimes it happens that titanic acid is spontaneously precipitated by degrees in the acetic liquid. The galliferous arsenic sulphide is treated as directed. (*Comptes Rendus* August, 1883, p. 522). We rarely obtain thus at the outset a salt of gallium absolutely free from titanic acid, but the titaniferous gallium may be converted into sulphate and the same method applied again.

4. Tartaric acid and a salt of manganese are introduced into the hydrochloric or sulphuric solution of the titano-gallic compound; it is supersaturated with ammonia, and ammonium sulphate is added. The galliferous maganese sulphide is very carefully washed, and then treated as laid down. (*Comptes Rendus*, June, 1882, p. 1626.) This method is especially applicable to the extraction of traces of gallium mixed with large quantities of titanic acid.

5. When the titano-gallium mixture is in a hydrochloric solution it may be evaporated to dryness, raising the temperature finally to 120°, and treating the residue in heat with dilute hydrochloric acid. There remain along with the titanic acid mere traces of gallium, which may be neglected in an ordinary analysis. In an exact determination the residue of titanic acid must be attacked with sulphuric acid or ammonium bisulphate, and the traces of gallium extracted by means of one of the other methods.

Titanic acid, obtained by evaporating its hydrochloric solution, passes easily through ordinary filters. The solution can be obtained clear only by dissolving in it ammonium hydrochlorate and making use of a very compact filter.—*Comptes Rendus.*

INSOLUBLE PHOSPHATES.

By FREDERICK JAS. LLOYD, F.C.S.

In the analysis of superphosphates it is customary to estimate with the greatest care the phosphoric acid soluble in water, but all the remaining phosphates are classed as "insoluble." This method, besides taking no notice of the existence of precipitated or retrograde phosphates, disregards the exact composition of these insoluble phosphates, and the part they would play as manures.

The usual method of estimating "insoluble phosphates" is as follows:—After washing out the soluble phosphate from a given quantity of the manure, the remainder is burnt, dissolved in hydrochloric acid, the insoluble silica filtered off, and the filtrate made ammoniacal. The precipitate thrown down is collected, washed, burnt, and weighed, and receives the indefinite term "insoluble phosphates." The insoluble phosphates thus obtained are easily divided into two classes, those which after burning are "white," and those which are "red."

During the last five years, while acting as assistant chemist at the Royal Agricultural Society, I performed a great number of such analyses, collected these precipitates separately, and have recently investigated them.

The "white" precipitates are only obtained from manures made with bones, and represent approximately the amount of bone phosphate left undissolved, though it

does not attempt to, nor does it, show the exact state in which these phosphates exist. That they are not in the form of bone phosphate, I have ample evidence to prove.*

Being anxious to know the real composition of the "red" insoluble phosphates, and having collected 17 grms. of these precipitates, which would represent far more than 100 samples analysed, their composition was carefully determined, with the following results:—

Composition of "Red" Insoluble Phosphates.

Lime	32·53
Oxide of iron	31·80
Phosphoric acid	35·77
	100·10

I was somewhat surprised at being unable to obtain any estimable quantity of alumina. If there had been sufficient quantity of lime present to combine with the whole of the phosphoric acid, these insoluble phosphates would have contained 78 per cent of phosphate of lime, or only a little more than three-quarters the quantity of phosphate they are supposed to represent. But they contain neither enough lime nor enough iron to combine alone with the phosphoric acid, though together these are more than sufficient. Hence one of these must be present in the state of oxide. The only probable assumption is that the iron exists partly as oxide, and that the exact composition of the "red" insoluble phosphates is—

Phosphate of lime	60·01
Phosphate of iron	17·63
Oxide of iron	22·46
	100·10

Thus it is seen that these red insoluble phosphates contain only 60 per cent of phosphate of lime instead of 100.

The manifest error which the present method of estimating insoluble phosphates entails makes it a subject of importance alike to agriculturists and to chemical manure manufacturers. The present estimated value of insoluble phosphates is 2s. per unit, and in buying manures by guarantee the farmer pays this sum for every unit of so-called "insoluble phosphates," whether he receive for his money really bone phosphate, or whether he is simply paying for oxide of iron. The manure manufacturer is equally unfairly treated, for how can the manufacturer who puts bone in his manure compete with the manufacturer whose manure contains mineral matters rich in iron, which iron is in the analysis put down as of equal value to bones. The error is detrimental to all parties alike. It is a subject which those who have the interest of the farmers at heart should enquire into, and it might be well for the recently-formed chemical section of the London Chamber of Commerce to take some steps in the matter.

A few experiments were made in the endeavour to get rid of the error without at the same time entailing on the analyst the necessity of the usual tedious estimation of phosphoric acid, but as these experiments did not succeed they do not require enumerating.

Laboratory,
49, Bloemfontein, Shepherd's Bush,
London, W.

The Cause of the Decrease of Tartar in Plastered Wines.—P. Pichard.—The author considers that the cause is not a decomposition of the tartar, but on its reduced solubility in presence of a certain quantity of potassium sulphate. The author utilises this property for determining potassium bitartrate. Free tartaric acid interferes with this process, which is inapplicable in case of plastered wines. Malic and succinic acids do not interfere.—*Biedermann's Centralblatt.*

* See "Retrograde Phosphates," *Chem. Soc. Journal*, 1882, p. 314.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

CALCIUM.

FOR determining the atomic weight of calcium we have sets of experiments by Berzelius, Erdmann and Marchand, and Dumas. Salvétat† also has published an estimation but without the details necessary to enable us to make use of his results. I also find a reference‡ to some work of Marignac; which, however, seems to have been of but little importance. The earlier work of Berzelius was very inexact as regards calcium, and it is not until we come down to the year 1842 that we find any material of decided value.

The most important factor in our present discussion is the composition of calcium carbonate, as worked out by Dumas and by Erdmann and Marchand.

In 1842 Dumas‖ made three ignitions of Iceland spar, and determined the percentages of carbon dioxide driven off and of lime remaining. The impurities of the material were also determined, the correction for them applied, and the weighings reduced to a vacuum standard. The percentage of lime came out as follows:—

56·12
56·04
56·06

Mean 56·073 ± 0·016

About this same time Erdmann and Marchand§ began their researches upon the same subject. Two ignitions of spar, containing 0·04 per cent. of impurity, gave respectively 56·09 and 56·18 per cent. of residue; but these results are not exact enough for us to consider further. Four other results obtained with artificial calcium carbonate are more noteworthy. The carbonate was precipitated from a solution of pure calcium chloride by ammonium carbonate, was washed thoroughly with hot water, and dried at a temperature of 180°. With this preparation the following residues of lime were obtained:—

56·03
55·98
56·00
55·99

Mean 56·00 ± 0·007

It was subsequently shown by Berzelius that calcium carbonate prepared by this method retains traces of water even at 200 degrees, and that minute quantities of chloride are also held by it. These sources of error are, however, in opposite directions, since one would tend to diminish and the other to increase the weight of residue.

In the same paper there are also two direct estimations of carbonic acid in pure Iceland spar, which correspond to the following percentages of lime:—

56·00
56·02

Mean 56·01 ± 0·007

In a still later paper¶ the same investigators give another series of results based upon the ignition of Iceland spar. The impurities were carefully estimated, and the percentages of lime are suitably corrected:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Comptes Rendus*, 17, 318. 1843.
‡ See Oudeman's Monograph, p. 51.
‖ *Comptes Rendus*, 14, 537. 1842.
§ *Journ. f. Prakt. Chem.* 26, 472. 1842.
¶ *Journ f. Prakt. Chem.*, 31, 269. 1844.

4·2134 grms.	$CaCO_3$ gave	2·3594	CaO.	55·997 per cent.
15·1385	,,	8·4810	,,	56·022 ,,
23·5503	,,	13·1958	,,	56·031 ,,
23·6390	,,	13·2456	,,	56·032 ,,
42·0295	,,	23·5533	,,	56·044 ,,
49·7007	,,	27·8536	,,	56·042 ,,

Mean 56·028 ± 0·0047

Six years later Erdmann and Marchand* published one more result upon the ignition of calcium carbonate. They found that the compound began giving off carbon dioxide below the temperature at which their previous samples had been dried, or about 200°, and that, on the other hand, traces of the dioxide were retained by the lime after ignition. These two errors do not compensate each other, since both tend to raise the percentage of lime. In the one experiment now under consideration these errors were accurately estimated, and the needful corrections were applied to the final result. The percentage of residual lime in this case came out 55·998. This agrees tolerably well with the figures found in the direct estimation of carbonic acid, and, if combined with those two, gives a mean for all three of 56·006, ± 0·0043.

Combining all these series we get the following result:—

Dumas	56·073	± 0·016
Erdmann and Marchand	56·006	0·007
,, ,,	56·028	0·0047
,, ,,	56·006	0·0043
General mean..	56·0198	± 0·0029

For reasons given above this mean is probably vitiated by a slight constant error, which makes the figure a trifle too high.

In the earliest of three papers by Erdmann and Marchand there is also given a series of determinations of the ratio between calcium carbonate and sulphate. Pure Iceland spar was carefully converted into calcium sulphate, and the gain in weight noted. 100 parts of spar gave of sulphate:—

136·07
136·06
136·02
136·06

Mean 136·0525 ± 0·0071

In 1843 the atomic weight of calcium was re-determined by Berzelius,† who investigated the ratio between lime and calcium sulphate. The calcium was first precipitated from a pure solution of nitrate by means of ammonium carbonate, and the thoroughly washed precipitate was dried and strongly ignited in order to obtain lime wholly free from extraneous matter. This lime was then, with suitable precautions, treated with sulphuric acid, and the resulting sulphate was weighed. Correction was applied for the trace of solid impurity contained in the acid, but not for the weighing in air. The figures in the last column represent the percentage of weight gained by the lime upon conversion into sulphate:—

1·80425 grms.	CaO gained	2·56735	grms.	142·295
2·50400	,,	3·57050	,,	142·592
3·90000	,,	5·55140	,,	142·343
3·04250	,,	4·32650	,,	142·202
3·45900	,,	4·93140	,,	142·567

Mean 142·3998 ± 0·0518

Last of all we have the ratio between calcium chloride and silver as determined by Dumas.‡ Pure calcium chloride was first ignited in a stream of dry hydrochloric acid, and the solution of this salt was afterwards titrated with a silver solution in the usual way. The $CaCl_2$ proportional to 100 parts of Ag is given in a third column:—

2·738 grms.	$CaCl_2$ =	5·309	grms. Ag.	51·573
2·436	,,	4·731	,,	51·490
1·859	,,	3·617	,,	51·396
2·771	,,	5·3885	,,	51·424
2·240	,,	4·3585	,,	51·394

Mean 51·4554 ± 0·0230

We have now four ratios to calculate from, as follows:—

(1)	Per ct. of CaO in $CaCO_3$,	56·0198	± 0·0029
(2)	CaO : SO_3 :: 100 :	142·3998	0·0518
(3)	$CaCO_3$: $CaSO_4$ :: 100 :	136·0525	0·0071
(4)	Ag : $CaCl_2$ :: 100 :	51·4554	0·0230

These give us the subjoined values for calcium:—

From (1)	Ca = 39·955	± 0·011
From (2)	,, = 40·139	0·023
From (3)	,, = 39·925	0·068
From (4)	,, = 40·069	0·058
General mean..	,, = 39·990	± 0·010

If O = 16, then Ca = 40·082.

A glance at the above figures will show that if, as is probable, the value deduced from the composition of calcium carbonate is a trifle too high, the general mean must be too high also. It is, therefore, interesting to see what results the very latest of Erdmann and Marchand's experiments will lead to. They found, after taking every precaution, in a single experiment that calcium carbonate yielded 55·998 per cent. of lime. From this we get Ca = 39·905; or, if O = 16, Ca = 39·997. It is possible, then, that "Prout's law" may hold good for calcium.

PAPERS UPON INDUSTRIAL CHEMISTRY.

By Prof. ALBERT R. LEEDS., Ph.D.

A New Scheme for the Analysis of Soap.

(1). *Water.*—Weigh out about 5 grms. in very fine, small shavings upon a dried, weighed, plated filter. Dry at 110° until weight is constant. The loss is water.

(2). *Uncombined Fat.*—Transfer the filter containing the dried soap to the funnel connected with the return cooler, such as is used in the determination of the albumenoids in milk, and connect with the funnel a small tared flask, containing 50 c.c. petroleum ether. After complete extraction distil off the ether, and the residue in the flask, dried at 110°, will be the uncombined fat.

(3). *Soap*; (4). *Free Alkali*; (5). *Glycerin.*—Allowing the funnel, with the soap freed from moisture and from fat, to remain on the return cooler, attach to it a flask containing about 75 c.c. of 95 per cent alcohol and extract. To the alcoholic solution add a few drops of phenolphthalein; if free acid be present, neutralise with normal sulphuric acid, and calculate the amount of uncombined soda.

After neutralisation add a large excess of water and boil off the alcohol. To the aqueous solution add a large excess of normal sulphuric acid. Boil, cool, and decant through a small filter, wash with hot water and decant after cooling through the filter until litmus-paper is no longer reddened by the washings. The filtrate consists of the combined soda and glycerin, the residue of the fatty acids and resin.

Neutralise the filtrate with normal soda solution and calculate the amount of combined soda as Na_2O. Evaporate to dryness, and extract the glycerin with absolute alcohol. Transfer the alcoholic solution to a tared flask, distil off the alcohol, dry at 100°, and weigh the residue as glycerin.

Fatty Acids and Resin.—Dissolve the small amount of the fatty acids and resin that may be on the filter through which the decantation was effected with a little petroleum

* *Journ. f. Prakt. Chem.*, 50, 237. 1850
† *Journ. f. Prakt. Chem.*, 31, 263. *Ann. Chem. Pharm.*, 46, 241.
‡ *Ann. Chim. Phys.* (3), 55, 129. 1859. *Ann. Chem. Pharm.*, 113, 34.

DR. LEEDS'S SCHEME FOR SOAP ANALYSIS.

Weigh out 5 grammes. Dry at 110°. Loss corresponds to water.

Treat with petroleum ether.

Extract is uncombined fat. Dry at 110° and weigh.

Residue is soap and mineral constituents. Treat with alcohol.

Extract is soap (fatty anhydride, resin, and combined alkali), glycerin, and free alkali. Add two or three drops of phenol-phthalein. If necessary, titrate with normal sulphuric acid.

H_2SO_4 used corresponds to free alkali. Calculate as NaHO.

Add a large excess of water and boil off the alcohol. Decompose with excess of normal H_2SO_4. Boil, filter, and wash.

Filtrate.—Combined soda and glycerin. Titrate with normal soda solution.

H_2SO_4 used corresponds to combined soda in soap. Calculate as Na_2O.

After titration evaporate to dryness on the water-bath. Treat with absolute alcohol. Evaporate the alcoholic solution to dryness in a tared dish and weigh as glycerin.

Residue.—Fatty acids and resin. Dry at 110° and weigh. Dissolve an aliquot part in 20 c.c. strong alcohol, and, using phenol-phthalein as an indicator, saponify with soda in slight excess. Boil, cool, and add ether to 100 c.c. Decompose with $AgNO_3$ by adding in fine powder, and shake well for ten minutes. Allow to settle.

Precipitate is stearate, palmitate, and oleate of silver.

Solution.—Resinate of silver. Filter 50 c.c. from the total 100 c.c. Decompose with 20 c.c. HCl (1 : 2). Allow the AgCl to settle, and evaporate an aliquot part of the ethereal solution in a tared dish. Dry at 110° and weigh. After applying collection for oleic acid, the weight corresponds to the resin. This weight subtracted from the combined weight of fatty acid and resin gives the fatty acids.

Residue.—Na_2CO_3, NaCl, Na_2SO_4, sodium silicate, starch, and insoluble residue. Wash with 60 c.c. water.

Filtrate.—Na_2CO_3, NaCl, Na_2CO_4, and sodium silicate. Divide into four equal parts.

Na_2CO_3. Titrate with normal H_2SO_4, and calculate as Na_2CO_3.

NaCl. Titrate with $AgNO_3$ or weigh as AgCl. Calculate as NaCl.

Na_2SO_4. Weigh as $BaSO_4$. Calculate to Na_2SO_4.

Sodium silicate. Decompose with HCl and determine soda combined in silicate and silica.

Residue.—Starch and insoluble residue. Dry the filter and weigh. The weight is the starch and insoluble residue. Starch.—Convert the starch into $C_6H_{12}O_6$. Titrate with Fehling's solution. Subtract the weight of starch found, and the difference is the insoluble mineral constituents.

ether, add the solution to the larger bulk in the beaker, evaporate off the ether, dry at 100°, and weigh the combined fatty acids. Multiply this result, after subtracting the amount of the resin, by 0·97, and the product is the fatty anhydrides.

(6). *Resin.*—The resin was separated from the fatty acids according to the method proposed by Gladding (*Amer. Chem. Journ.*, vol. iii., p. 416). About 0·5 grm. of the mixture of the fatty acids and resin are dissolved in 20 c.c. of strong alcohol, and with phenol-phthalein as an indicator, soda is run in to a slight supersaturation. The alcoholic solution, after boiling for ten minutes to ensure complete saponification, is mixed with ether in a graduated cylinder till the volume is 100 c.c. To the alcoholic and ethereal solution 1 grm. of very finely powdered $AgNO_3$ is added, and the contents of the cylinder are shaken thoroughly for ten or fifteen minutes. After the precipitate has settled, 50 c.c. are measured off, and if necessary filtered into a second graduated cylinder. A little more $AgNO_3$ is added to see if the precipitation is complete, and then 20 c.c. of dilute hydrochloric (1 : 2) to decompose the silver resinate. An aliquot part of the ethereal solution in the cylinder is evaporated in a tared dish, and weighed as resin, deducting a small correction (for 10 c.c. deduct 0·00235 grm.) for oleic acid. The amount of resin subtracted from the combined weight of fatty acids and resins, as found before, gives the fatty acids.

(7). *Sodic Carbonate;* (8). *Sodic Chloride;* (9). *Sodic Sulphate;* (10). *Sodic Silicate;* (11). *Insoluble Residue.*—The filter in the funnel connected with the return cooler, after treatment with alcohol, contains the mineral constituents of the soap. The contents of the filter are washed with cold water till the washings amount to 60 c.c. The filter is then dried and weighed. The weight gives the insoluble residue and starch.

The starch is converted into $C_6H_{12}O_6$ with dilute acid, and titrated with Fehling's solution. The weight of starch found, subtracted from the total weight of insoluble residue and starch, gives the insoluble mineral coustituents.

The aqueous solution of 60 c.c., just mentioned, is divided into four equal parts, in one of which is determined the carbonate of soda, by titration, and in the other parts the chloride, the sulphate, and the silicate respectively, by any convenient method.

ON A NEW DEVICE FOR DETERMINATION OF CARBON IN CAST IRON.

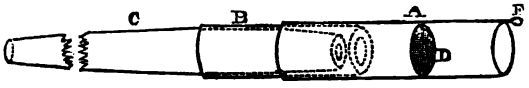
By A. A. BRENEMAN, S.B.

THE carbonaceous residue obtained when cast-iron is dissolved is commonly transferred with the mass of asbestos serving as a filter to the combustion-tube. To avoid accidents incident to this transfer, and to ensure the combustion of refractory portions of graphite, the writer has adopted the modifications of the process described below. A brief note upon the process was read at the meeting of the American Association in 1879, but the success attending its use since then by students under the writer's direction, as well as the introduction of some minor improvements, has led him to believe that a fuller description of the process might be useful to others. The process depends in the main upon the use of combustion-tubes of porcelain, and the employment of a small tube of platinum as a filtering tube, which is subsequently put with its contents into the combustion-tube and heated in a stream of oxygen in presence of cupric oxide in the usual way.

The details of the filtering apparatus will be best understood from the figure.

A is a tube of moderately thick platinum foil, somewhat thicker than that used in blowpipe work, B is a piece of soft rubber tubing fitting snugly within A. C is a piece of glass combustion-tubing, tapered at each end as shown, and having a length of about 12 c.m. Other dimensions are as shown in the figure, viz., A 45+13 m.m., B 40 m.m. in length. A may vary in dimension according to circumstances.

The apparatus is connected together by pulling or pushing the tube B over the tapering end of C after it has been loosely inserted in A. All pressure upon A is thus avoided. The joint is air-tight. When not in use A is slipped over a piece of glass tubing of proper size to protect it from injury. The loop F serves to introduce a slightly hooked glass rod by which A is moved into the combustion-tube or withdrawn from it. The disc D is of platinum foil, perforated, and when in use rests on the end of B within A, and supports the asbestos used in filtration. A small funnel serves to convey liquids to the filtering tube. The filtering tute A with its contents, when dry, is separated from B and C and introduced into the combustion-tube, where it is heated in a current of oxygen as mentioned, in the usual way.



The tube A is easily made in the laboratory, being shaped over a piece of combustion-tubing and soldered with gold leaf. It should fit snugly within the porcelain tube, so that oxygen may pass mainly *through* the filter and its contents. It is not difficult to find porcelain tube of a proper size to suit the platinum tube, and in case of difficulty the latter can be enlarged by rubbing it with a stout glass rod while held on a piece of combustion-tubing or reduced in size by cutting and re-soldering.

The use of porcelain tubes is of advantage not only because of the high temperature attainable, but also because the average *life* of such a tube is greater than that of a quantity of glass combustion-tubes costing an equal sum; with the certainty of perfect combustion that is assured in their use, the convenience of seeing the substance under combustion disappears.

The tubes of platinum seem to suffer little in use. One of them has sufficed for about fifty combustions and is still perfectly good.—*Journ. Am. Chem. Soc.*

CORRESPONDENCE.

VOLUMETRIC ARSENIC.

To the Editor of the Chemical News.

SIR,—My criticism upon Mr. Pearce's method of neutralising the alkaline arseniate solution *is* unsound. Mr. Low, in an article which appeared in the CHEMICAL NEWS, vol. xlviii., p. 85, has clearly demonstrated this fact. Consequently, I retract my statement to the effect that the solution immediately prior to precipitation dare not be alkaline. Had the short article in "Science" been more explicit as regards the rules to be observed in neutralising, this misunderstanding between Mr. Low and myself would never have arisen. In said article there is not so much as a hint that a second neutralisation, after filtering or simply mixing the nitrate of silver and arseniate of sodium, is essential. Mr. Low, however, not only in his own paper, but also in his abstract (?) of one by Mr. Frost, which first appeared in the *Engineering and Mining Journal*, shows plainly that an after neutralisation is occasionally requisite. As regards the possibility of using nitrate of silver and thiocyanate of ammonium in estimating phosphorus, I would observe that the subject has been elaborately worked up by Drs. Kratschmer and Stancovansky, in the *Zeits. für Anal. Chem.*, xxi., 253. Mr. Low's explanations are sufficiently clear to remove

all doubts from my mind as to the reliability of Mr. Pearce's method.—I am, &c.,

LEROY W. MCCAY.

Princeton, September 14, 1883.

YELLOW HYDROCHLORIC ACID.

To the Editor of the Chemical News.

SIR,—"Practical Chemist," in the CHEMICAL NEWS, vol. xlviii., p. 94, calls attention to a statement made by Roscoe and Schorlemmer in their "Treatise on Chemistry" to the effect that the yellow colour of raw hydrochloric acid is due to the presence of *organic matter*. Permit me, if you please, to say a word on this subject.

About a year ago, while stopping in Birmingham, I had an opportunity to examine a carboy of raw hydrochloric acid, which had been sent from an alkali work to the laboratory of a friend of mine, chemist for a certain metal manufacture situated on the outskirts of the city. My friend pronounced the deep yellow colour the result of the presence of organic matter. I failed to agree with him, being well satisfied that the colour was due to ferric chloride. To settle the matter we first endeavoured to discharge, or, at least, partially lighten, the depth of tint of a sample by oxidising the organic matter assumed to be present. Neither potassic chlorate nor permanganate succeeded in producing a definite result, spite the application of heat. Ammonia in excess, however, occasioned a heavy precipitate of ferric hydrate, which, after subsiding, left the supernatant liquid of a light *blue* hue. This blue colour was evidently due to the presence of copper. We made a rough estimation of the iron present, and were astonished to find the percentage so high. The exact amount, I regret to state, has escaped my memory. It may be well to call attention to the fact that Lunge ("Sulphuric Acid and Alkali," vol. ii., 179-81) does not mention organic matter as one of the *ordinary* impurities of crude hydrochloric acid.—I am, &c.,

LEROY W. MCCAY.

Princeton, September 14, 1883.

ALCHEMICAL TRICKS IN AFGHANISTAN.

To the Editor of the Chemical News.

SIR,—The late Lieut.-Col. Sir Alexander Burnes's, on his visit to Cabul in 1837, found the inhabitants of Afghanistan practising alchemical tricks similar to those which had obtained in Europe from the days of Raymund Lully to the middle of the eighteenth century. His account being quite brief I quote it entire:—

"One of the first applications which we received was from the Nawab, who requested us to supply him with some platina wire to aid his studies in alchymy. I took the occasion to inquire into the state of the science, which has always been in such high favour among the Afghans, and was forthwith made acquained with several ways of *making gold*, by which the adepts trick their credulous employers. One of these is by secretly introducing some gold inside the charcoal, and, after the quicksilver has been evaporated, the more precious metal is left to delight the wiseacre, and to tempt him on to further expenses. Another method is to put the filings of gold in a stick or pipe, and fasten the end with wax; with this rod the materials in the crucible are stirred, and the desired result obtained." ("Cabool: a Personal Narrative of a Journey to and Residence in that City in the years 1836, 7, and 8," by the late Lieut.-Col. Sir Alexander Burnes. 8vo., Philadelphia, 1843.)

This shows that the Afghans possessed, in common with the Chinese, Arabians, and many eastern people, much skill in chemical operations, and an ingenuity in deceiving their fellows worthy of a better cause. The whole passage reminds one of Chaucer's Canon Yeomen's tale, and of the exposure of transmutations presented to the French Academy by Geoffroy.—I am, &c.,

H. CARRINGTON BOLTON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 10, September 3, 1883.

A Process for the Extraction of Alcohol by means of the Juice of the Melon.—M. Levat.—The author has obtained alcohol from melons after a preliminary treatment with dilute sulphuric acid.

Panary Fermentation.—G. Chicandard.—A reply to MM. Marcano, Moussette, and Boutroux.

No. 11, September 10, 1883.

Separations of Gallium.—Lecoq de Boisbaudran.—See p. 164.

Filtration of very Minutely-divided Precipitates.—Lecoq de Boisbaudran.—It is known that certain precipitates, such as sulphur, in emulsion pass through filter-paper. The author often employs a method which in many cases obviates this inconvenience, and which, to his knowledge, has not yet been made public. Filter-paper is boiled with *aqua regia* until the mass is fluidified; it is then poured into a large quantity of water, and the white precipitate formed is washed by decantation. To render the texture of a filter very compact it is filled with this material, previously stirred up in water, so as to form a very thin paste, and allowed to drain. The paper is thus covered with a layer, which obstructs its pores. Or a little of the same pasty matter may be mixed with the liquid to be filtered.

Experiments made by M. Marcel Deprez at Grenoble, on the Transmission of Power by Electricity.—M. Boulanger.—The author gives his results in the form of tables.

The Cholera from a Chemical Point of View.—Ramon de Luna.—The author contends that the cause of cholera is always in the air, and that its action is exclusively exerted by the respiratory organs. The only means of saving persons attacked is causing them to inhale "with prudence" hyponitric vapour mixed with air.

The Absorption of the Ultra-violet Rays by Albumenoid Substances.—J. L. Soret.—All the albumenoid substances studied contain a common principle, to which their characteristic absorption-band is due. Gelatin, which differs from albumen in many other respects, behaves quite otherwise; it is much more transparent, and shows no band.

Memoir on Flours: Causes of their Decomposition.—M. Balland.—Corn contains an insoluble organised ferment which resists a dry heat of 100°. Its action is to fluidify the gluten.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 8.

Influence of Superphosphate upon the Quality of the Harvest.—Prof. Farsky.—The author concludes that superphosphates act like a stimulant, enabling a plant to complete its growth in a shorter time. They increase both the absolute and the relative weight of the seed. Soda-saltpetre in no case increases the weight of the seed, and retards the harvest.

The Reduction of Nitrates in Arable Soil—MM. Déherain and Maquenne.—The loss of nitrates is due to a "butyric acid ferment," which is developed only in soils completely deprived of oxygen. One of the causes why meadow land is richer in nitrogen than arable soils is the retardation of the process of nitrification.

Influence of Steam Ploughing upon the Quantity of the Yield.—Prof. Mærcker.—This paper has no chemical bearings.

Experiments with Farm-yard Manure and Artificial Fertilisers.—L. Guillaume.—In accordance with Dehérain, Corenwinder, and Pagnoul, the author finds that upon a soil which has been for many years in a well-manured condition, the action of phosphates and even of superphosphates is very slight, the increase of the crop being not sufficient to cover the outlay.

Action of Soluble and Insoluble Phosphates on Barley.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

Manurial Experiments in the Province of Posen.—Dr. E. Wildt.—An account of a number of experiments yielding no decisive results.

Cultivation in the Experimental Field at Grignon in 1882.—P. P. Déherain.—A discussion of the effects of manures, and also of the temperature and rainfall of the year as compared with those of 1880.

Earth-nut Cake and Earth-nut Meal.—Prof. Holdefleiss.—These articles, having had an unfavourable action when used for cattle food, were submitted to microscopic examination, and found to contain the spores of microphytes in great numbers.

American Milk.—Dr. E. H. Jenkins.—The author points out the fluctuations in the total solids of the milk of single cows.

Studies on the Ripening of Grapes.—Dr. C. Amthor.—During the process of ripening a portion of the potassa which previously existed in the state of phosphate combines with tartaric acid.

On Cheese from Skimmed Milk with Foreign Fats.—X. A. Willard, A. B. Griffiths, and J. van den Bergh.

Adulteration of Butter and its Detection.—Dr. E. Schmidt.—The author has obtained good results with Hehner's method only. He rejects especially the process of Husson, and also the methods founded on the determination of specific gravity, and on observation under the microscope (pure butter gives crystals). In examining samples a specimen of pure butter from the same locality ought always to be compared.

Zeitschrift für Analytische Chemie.
Vol. xxii., Part 3, 1883.

Detection of Iodoform, Naphthol, and Chloroform in Animal Fluids.—S. Lustgarten.—A very small quantity of sodium-phenol (or of resorcine) is placed at the bottom of a very short test-tube. One to three drops of the alcoholic solution is then added, and the tube is warmed cautiously over a small flame. In a few seconds there appears a red coating at the bottom of the tube and dissolves in a few drops of dilute alcohol with a carmine colour. In applying this test to urine, Lustgarten distils about 50 c.c.; mixes the neutral distillate with potassa, and shakes it up with ether in a separating-funnel. The ethereal extract is dried at a common temperature, and the residue taken up with a few drops of absolute alcohol. Blood is treated in a similar manner, but alkali should be added before distillation, and the ethereal extract should be mixed with a few drops of sulphuric acid in order to fix bases. For the detection of naphthol the author utilises its behaviour with chloroform in presence of alkali. If α- or β-naphthol is dissolved in strong potassa, mixed with chloroform, and heated to 50°, a rich blue liquid is obtained, which on exposure to the air passes first to a green and then to a brown. With acids the blue solution turns to a red. For the detection of naphthol in urine, Lustgarten acidifies strongly with hydrochloric acid, distils off about one-half, and extracts the naphthol from the distillate with ether. The residue on the evaporation of the ether is dissolved in potassa, and serves for the application of the test. The distillate may be advantageously treated with animal charcoal at a gentle heat. The same reaction serves inversely for the detection of chloroform.

Crystalline Methæmoglobine.—G. Hüfner and J. Otto.—The authors have succeeded in obtaining this compound in crystals and determining its solubility and colouring-power.

The Behaviour of "Carbon-monoxide Blood" with Hydrogen Sulphide.—E. Salkowski.—Normal blood if diluted with water and shaken up with sulphuretted hydrogen, assumes in a few minutes a dirty green colour. Blood which has absorbed carbon monoxide has its red colour not affected.

Detection of Paralbumen.—E. Salkowski.—The author recommends to add to the diluted liquid in question a few drops of an alcoholic solution of rosolic acid, heat to a boil, and add from a burette decinormal sulphuric acid, stirring occasionally, till the red colour disappears. Serous fluids if thus treated give a clear filtrate. A turbid filtrate indicates paralbumen.

Destruction of Animal Matter.—Paul Jeserich.—Preparatory to the examination for mineral poisons the author destroys the organic matter with free chloric and hydrochloric acids. The mass, comminuted as far as possible, is made up to a thin paste with water, and, after the addition of a little chloric acid, is slowly and cautiously heated on the water-bath, adding gradually more chloric acid in small portions. When the mass swells up like a sponge small quantities of hydrochloric acid are gradually added, but so that the chloric acid may remain in excess. The loss by evaporation must be compensated by the addition of water to prevent the reaction from becoming too violent. The operation is complete in two to three hours.

Detection of Arsenic in Tissues, Paper-hangings &c.—H. Fleck.—The author digests for eighteen to twenty-four hours at 50° to 60° with 50 to 100 grms. of pure sulphuric acid at 25 per cent. If any colours remain upon the objects, an addition of 3 to 5 grms. of pure nitric acid is recommended. The whole is filtered, the residue washed, and the liquids evaporated in a porcelain capsule (if nitric acid has been employed, otherwise not), and the volume is made up to 200 c.c. The detection of arsenic in the liquid is effected by the Marsh process.

Forms for a General Arsenic Regulation.—G. Thoms.—The author proposes to classify articles examined, according to the nature of the mirror produced in ten minutes, as "strongly arseniferous, arseniferous, slightly arseniferous, or free from arsenic," the two former classes being pronounced dangerous to public health. Dragendorff and Reichardt point out certain difficulties, and especially object that a mere knowledge of the presence of arsenic in articles of commerce is insufficient without we know also the state in which it occurs.

Apparatus for the Detection and Quantitative Determination of Arsenic.—J. A. Kaiser.—The apparatus is not described.

Journal de Pharmacie et de Chemie.
Tome viii., September, 1883.

Historical Part of the Discovery of Artificial Soda.—M. Dumas.—Already noticed.

The Toxical Action and the Therapeutical Use of Potassium Dichromate.—M. Vulpian.—A few cases of fatal poisoning with this salt are given. The rapidity with which death comes on is remarkable. It is asserted,

in a passage taken from the *Lancet*, that there are only six manufacturies of the chromates in the world, "three in Glasgow, and the three others in Austria and in the United States." [The writer has omitted the works of Norris Bros. at Sowerby Bridge, near Halifax, where the chromates are manufactured on a large scale.]

Re-solution of Urinary Pigments in Order to Facilitate the Microscopic Examination of Urinary Sediments.—C. Méhu.—The author makes use of a solution of the ordinary sodium phosphate. This solution, saturated in the cold, dissolves, very readily, urobiline, uroerythrine, and the ordinary bile pigments, such as bilirubine and biliverdine.

Action of Fuming Nitric Acid upon Mono-chloric Camphor: Formation of Chloro-nitric Camphor.—M. Cazeneuve.—Already noticed.

MISCELLANEOUS.

Resignation.—Mr. F. J. Lloyd, F.C.S., has resigned his post of Assistant Chemist at the Royal Agricultural Society, which he has held for nearly five years.

British Association for the Advancement of Science.—The following is a complete list of the Committee of Section B (Chemical Science) of the Southport Meeting of the British Association:—A. H. Allen; Prof. J. Attfield, F.R.S.; P. Braham; W. Lant Carpenter, B.A., B.Sc.; Prof. Clowes, D.Sc.; J. T. Dunn, M.Sc.; T. Fairley; A. E. Fletcher; S. Leigh Gregson; F. Hodges; C. T. Heycock, B.A.; Prof. W. N. Hartley; B. P. Lascelles, B.A.; Prof. McLeod, F.R.S.; R. Meldola; R. J. Moss; E. K. Muspratt; Dr. F. Mylius; Stevenson Macadam, Ph.D.; Dr. R. T. Plimpton; Dr. Perkin, jun.; Rev. S. J. Perry, F.R.S.; Prof. W. Ramsay, Ph.D.; Prof. Chandler Roberts, F.R.S.; A. Scott, M.A., D.Sc.; A. Smithells, B.Sc.; G. Johnstone Stoney, M.A., F.R.S.; E. C. C. Stanford; Thomas Tyrer; William Thomson; R. Warington; M. Whitley Williams; Dr. Will; W. Marshall Watts, D.Sc.; G. Ward; Prof. W. Carleton Williams; C. R. A. Wright, D.Sc., F.R.S.; John Williams; J. A. Wanklyn; Sydney Young, D.Sc.

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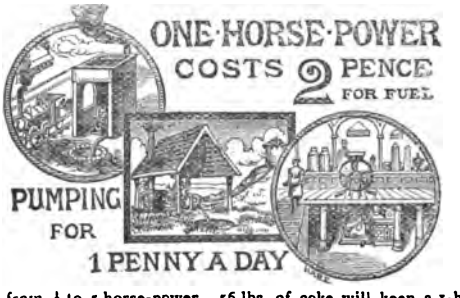

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1246.

COLOURING MATTERS OF THE DIAZO-GROUP.*

By RAPHAEL MELDOLA, F.C.S., F.I.C., &c.

THE author gave a short historical sketch of this important class of bodies, the discovery of which is due in the first place to Dr. P. Griess. Since the period of their discovery the colouring matters have been very largely investigated by many chemists, owing to their great technical importance, some of the scarlets belonging to the series having practically destroyed the cochineal industry. A large utilisation of many of the waste products of coal-tar, such as naphthalene and the higher homologues of benzene, has at the same time taken place. The compounds hitherto most closely investigated are those formed on the general type—

$$R—N=N—Ph.$$

The commercial products known as "Biebrich" and "Croceine" scarlets are secondary azo-bodies of the type—

$$R—N=N—R—N=N—Ph.$$

The author has discovered a method of preparing tertiary compounds of the type—

$$Ph—N=N—R—N=N—R—N=N—Ph.$$

The method consists in first preparing a nitro-derivative of an amido-azo compound:—

$$NO_2.R—N=N—R.NH_2.$$

The nitro-group can be reduced without severing the nitrogen atoms, and the products, consisting of a series of bases isomeric with those of the chrysoidine series, can be diazotised in both NH_2 groups and combined with two molecules of a phenol. The following reactions are typical:—

$$C_6H_4\begin{matrix}NH_2\\ N_2.C_8H_8.NH_2\end{matrix} + 2NaNO_2 + 4HCl = C_6H_4\begin{matrix}N_2.Cl\\ N_2.C_8H_8.N_2.Cl\end{matrix} + 2NaCl + 4H_2O \quad \ldots (1)$$

$$C_6H_4\begin{matrix}N_2.Cl\\ N_2.C_8H_8.N_2.Cl\end{matrix} + 2C_{10}H_7.ONa = C_6H_4\begin{matrix}N_2.C_{10}H_6.HO\\ N_2.C_8H_8.N_2.C_{10}H_6.HO\end{matrix} + 2NaCl \quad \ldots (2)$$

ON THE CONVERSION OF OLEIC ACID INTO PALMITIC ACID.*

By W. LANT CARPENTER.

MR. W. LANT CARPENTER read a short paper upon the Conversion of Oleic Acid into Palmitic Acid, and upon fusions with caustic alkalies upon a large scale. Referring to his paper on M. Radisson's process for the industrial conversion of oleic acid into palmitic acid, as printed in the *Journal of the Society of Chemical Industry*, he wished to supplement that with further details of the apparatus employed.

Particulars and dimensions were given of the vessel in which the reaction was effected, and the small limits of temperature within which the change took place were strongly insisted on. Provided attention were given to this, there was no difficulty in conducting these fusions with caustic alkalies, upon this very large scale, in iron vessels.

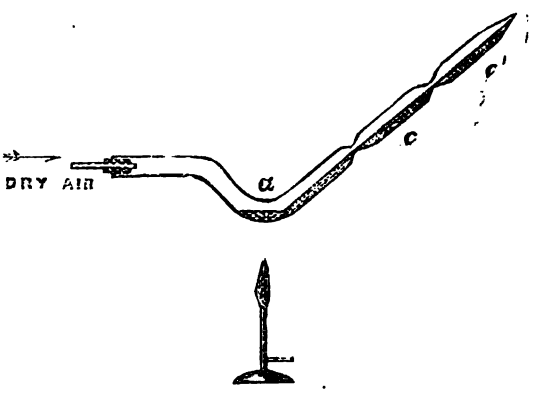
In connection with this solidification of oleic acid, the author pointed out the fact that the fat of all young animals was richer in oleic acid than that of adults; and also that in the case of adult animals, the better they were fed and cared for the richer was their fat in oleine, in addition to its total quantity being greater: on the other hand, the fat of a poorly-fed adult animal was comparatively poor in oleine, and rich in stearine and the harder constituents. Further, fragments of animal flesh, left in contact with oleic acid and water, effected a more or less complete transformation of oleic acid into harder fatty acids, the whole mass undergoing butyric fermentation at the same time. To what was this transformation of the oleic acid due? Was it possible that some special "microbe" or organism was concerned in the change? The author hoped to have the opportunity of making further researches into this point.

* Abstract of a Paper read before the British Association, Section B, South port Meeting.

ACTION OF SUNLIGHT ON PHOSPHOROUS ANHYDRIDE.*

By the Rev. A. IRVING, B.Sc.

THE only notice I have met with of this interesting example of the effect of a physical agent in promoting chemical change is found in Wislicenus's edition of Streeker's "Chemistry," a work well known in Germany. P_2O_3, when prepared in a perfectly anhydrous condition, by passing a very slow stream of well-dried air over molten phosphorus contained in the bend (*a*) of the wide tube shown in the figure, is carried along with the residual nitrogen, and deposited in the wider portions of the long arm of the tube, *c c'*, like small snow drifts. By sealing off the portions *c c'* the anhydrous P_2O_3 thus



obtained may be preserved from contact with atmospheric moisture and free oxygen, and *if kept in the dark* remains unchanged for any length of time. Its affinity, however, for free oxygen and water is shown by its *spontaneous ignition* when one of the tubes is broken, and the trioxide shaken out into the air. The mere heat of the flame used in sealing off the parts of the tube transforms the portion of the trioxide which is in contact with

* A Paper read before the British Association, Southport Meeting Section B).

the heated portion of the tube, a thin film of brown phosphorus being formed. The results of prolonged action of direct sunlight are, however, very striking, and as these have not found their way, so far as I am aware, into any of the text-books in vogue in this country, it has occurred to me as possibly worth while to bring the subject before this section, especially since the phenomena seem to suggest one or two points of considerable theoretical interest. A brief notice of the facts was sent in last year, but too late for acceptance by the committee; since then, however, I have had occasion to prepare P_2O_3 several times for lectures, and so have studied the whole thing somewhat more thoroughly. In every case the same results are obtained, if care be taken to dry the air thoroughly, to pass the current very slowly, and to keep the temperature of the phosphorus in the bend of the tube below the temperature which initiates full and complete combustion. The exposure of the sealed-up P_2O_3 to the action of direct sunlight for a few days produces an entire change in the nature and appearance of the contents of the tube: (1) the white colour of the P_2O_3 gives place to the red-brown of amorphous phosphorus; (2) the contents of the tube when thrown into the air are no longer spontaneously inflammable; (3) pure distilled water with which the tube is washed out precipitates a copious yellow powder with ammonium molybdate in the presence of strong HNO_3 even without warming. The amorphous phosphorus which is formed within the tube shows after a time a tendency by slow sublimation to assume the crystalline condition, arranging itself in beautiful moss-like forms of crystal-growth. Prof. Wislicenus suggests for the explanation of the observed transformation a reaction which is represented by the following equation:—

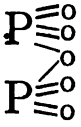
$$5P_2O_3 = 4P + 3P_2O_5.$$

The chief interest of the subject arises from the apparent interference with chemical equilibrium by a purely physical agent; aud further interest attaches to the process as furnishing a means for procuring very pure amorphous phosphorus on a small scale.

The *explanation* of the results observed which I venture to suggest is somewhat as follows:—

Regarding phosphorus as a pentavalent element in combination with oxygen, we may perhaps get to understand the remarkable instability manifested by the P_2O_3 if we represent its composition by the following graphic formula:—

The effect of sunlight* (or of heat) upon the molecule would seem to consist in altering the *relative* electrochemical energies of the two elements contained within it. In this way the double bond which holds P to P within the molecule would be severed. While, however, the mutual energy of these centres of saturation for one another is thus weakened or diminished to *nil*, their energy for combining with oxygen is so far increased that they can reduce contiguous molecules of P_2O_3 to amorphous phosphorus. The fully saturated condition of the element in combination with oxygen as P_2O_5 would then, perhaps, be shown in the formula:—



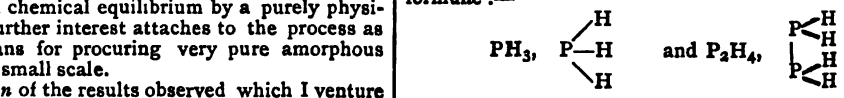
* We may perhaps regard (as Prof. Liveing suggested when this paper was read) the work of partial dissociation as affected by the heat into which the luminous solar radiation is transformed by absorption. If so, it may be further interesting to refer to a little piece of work done by the author last winter in connexion with the physics of glaciers. (See *Nature*, vol. xxvii., April 12, 1883.)

I have not met with any discussion of this interesting point in the various handbooks which have been written on Chemical Philosophy; even in that by Prof. Cooke, of America, it is passed over. In the preparation of P_2O_3 after the method described above, a slight trace of the anhydrous oxide is carried through the tube and escapes with the residual nitrogen into the air. It is too much diluted with nitrogen to become ignited, but passes rapidly into (probably) hydric metaphosphate by combination with atmospheric oxygen and water-vapour. The small stream of visible vapour thus formed does not move on in a continuous line, but folds back upon itself at intervals synchronous with the passage of the bubbles of air through the concentrated sulphuric acid in the desiccating portion of the apparatus. These small folds at once resolve themselves into small "smoke-rings," quite similar to those which are formed by the spontaneous ignition of a mixture of PH_3 and P_2H_4.

Further, we may extend the reasoning adopted above, to account for the instability of P_2O_3, to explain the spontaneous ignition of P_2H_4 vapour.

All the best text-books give a method for separating the heavy vapour of P_2H_4 which comes off with PH_3 from a boiling solution of vitreous phosphorus in potash, the method consisting essentially in the condensation of the vapour of P_2H_4 by a freezing-mixture. The fact that PH_3 is not *spontaneously* inflammable in air is thus demonstrated, though the same fact may be shown by the more simple process of the application of a taper-flame to the bubbles of PH_3 which escape through the water into which the gas is led, *before the water gets saturated with the vapour of* P_2H_4, and therefore before the "smoke-rings" begin to appear.

If we represent the constitution of the molecules of PH_3 and P_2H_4 respectively by the following graphic formulæ:—



the more unstable character of the latter body, and its consequent *spontaneous ignition in air*, would seem to be accounted for. The spontaneous ignition of P_2O_3 and of P_2H_4 are thus referred to one common principle of chemical theory.

Considerable theoretical interest seems to me to attach itself to both the instances considered, as illustrating the facility with which the intra-molecular constitution of some bodies may be disturbed, and the importance of *partial dissociation* as a preparatory stage to chemical reactions generally; and this must be my excuse for bringing so elementary a subject before the notice of this section.

ON THE EMPLOYMENT OF LIMED COAL IN GAS-MAKING.*

By J. ALFRED WANKLYN.

It has been known for some years past that, in the gas-manufacture as usually carried on, very much less than all the nitrogen contained by the coal is recovered in the form of ammonia. And, in general terms, it may be stated that whereas there is enough nitrogen in the coal employed in gas-making to furnish from 25 lbs. to 50 lbs. of ammonia per ton of coal, the average quantity of ammonia actually recovered is between 5 and 6 lbs. per ton of coal.

Within the last two years attempts have been made to diminish this waste of assimilable nitrogen. One of these attempts has been made in Scotland by Mr. Young, who consumes the heated coal in a current of steam. The

* A Paper read before the British Association, Section B, Southport Meeting.

other attempt, which is very nearly of the same date and quite independent, is embodied in Cooper's liming process, which forms the subject of this paper.

The idea which led up to Cooper's process was that it might turn out to be possible to augment the yield of ammonia with very little disturbance of the ordinary course of gas-manufacture, if a little lime were mixed with the coal as a preliminary to the introduction of the coal into the retort. In that manner it was imagined that without serious sacrifice, either of the gas or of the coke or of the tar, there might be an augmentation of the yield of ammonia. When the experiments were started in the laboratory, before the application was made for the patent, the various other advantages of the employment of a small proportion of lime began to come into view.

One of the earliest observations made by the patentee was that the gas issuing from limed coal, unlike the common gas, was fragrant rather than fœtid. Hence, at that early stage, the conclusion was drawn that liming the coal would conduce to the manufacture of pure gas.

In addressing the Chemical Section of the British Association I feel that there can be no necessity for me to explain why the addition of lime to coal should conduce to the formation of ammonia during the process of destructive distillation at a red-heat. In this connection it will suffice for me to anticipate the objection that 2½ per cent of lime (*i.e.*, the proportion which Cooper recommends) is too small a proportion, by the remark that some 70 per cent of the coal is, so to speak, immobile and goes to form the coke, whilst 30 per cent is mobile. On the mobile portion of the coal Cooper's 2½ per cent of lime is not a very small percentage.

As the investigation of Cooper's process progressed, the fact came to light that there is an increase in the yield of tar or in the yield of illuminating gas. At first sight the reason of this may possibly not occur to my hearers. But a little reflection will disclose it. Coal contains carbon, hydrogen, and oxygen, and also some nitrogen, sulphur, and certain fixed mineral matters. After the coal has been most thoroughly dried it will, nevertheless, yield water when it is distilled. In the ordinary distillation of coal very nearly all the oxygen of the coal unites with hydrogen and forms water. Now, suppose that by any means some of that oxygen could be caused not to unite with hydrogen to form water, then hydrogen would be saved for useful purposes, and would go either to augment the yield of gas or the yield of tar. The function of the lime at a red-heat is to hinder the formation of water, and in that manner the lime increases the yield of tar or of gas, as the case may be.

How liming the coal should tend to the production of a gas less charged than usual with sulphuretted hydrogen or sulphuret of carbon will be quite obvious, and needs no explanation.

As has been already said, in the first instance, the hope was indulged that the coke resulting from the carbonisation of the limed coal might prove to be only slightly injured. When the coke was actually produced it was found to be not only uninjured, but in some most important respects it was improved. The presence of the small quantity of lime renders the coke more easily combustible, and the lime acts either as a chemical or a mechanical oxygen carrier. Furthermore, the presence of the lime in the coke prevents the evolution of sulphurous acid when the coke is burned. It would be impossible to insist too strongly on this alteration in the character of the coke, and the introduction of Cooper's desulphurised coke for general consumption in towns will be an event of national importance.

I will now proceed to give an account of the trial workings of Cooper's process at different gas-works.

Gain in Ammonia.—A series of experiments was carried out under the direction of Mr. Trewby, C.E., the engineer in charge of the Beckton Gas-Works.

These experiments were made on a small scale, and gave as a mean result that there was a gain of 36 per cent of ammonia consequent on liming the coal. Another experiment at the Commercial Gas-Works, made under the direction of Mr. Jones, C.E., gave the gain of ammonia as 27 or 28 per cent. A third experiment, by Mr. Paterson, of the Cheltenham Gas-Works, was published by that gentleman in his presidential address to the Gas Institute at Sheffield. Mr. Paterson found a gain of 20 per cent of ammonia.

The foregoing results are important from the variety of conditions under which they were obtained, and from the eminence of the engineers who were concerned in them.

I will next mention some trial workings on a much larger scale. Fifty tons of coal were carbonised in the usual manner, and 30 gallons of 7·6 oz. liquor were obtained from each ton of coal.

Fifty tons of the same lot of coal were limed with 3 per cent of quicklime, which was slaked before mixing. The mixture was very imperfectly made. Thirty-five gallons of 8·7 oz. liquor were obtained from each ton of coal. The following is a comparison of the results:—

Unlimed coal	30 by 7·6 = 228·0
Limed coal	35 by 8·7 = 304·5

showing a gain by Cooper's process of 35 per cent of liquor.

In a further trial at another gas-works a different description of coal was taken. The coal gave in the usual way only 21 gallons of 8 oz. liquor; but when limed with 2½ per cent of quicklime, slaked before admixture, it gave 42 gallons of 8·1 oz. liquor.

At a gas-works in the South of England, where no cannel is used, Cooper's process has been worked continuously for six weeks, about 50 tons of coal being carbonised daily. The admitted gain is 3 gallons of 8 oz. liquor.

At a gas-works in Liverpool, where much cannel is employed, the process has been worked continuously for between three and four months, on a daily carbonisation of 50 tons of coal, and a gain of 5 gallons of 8 oz. liquor is admitted.

In the course of the last few years I have had abundant opportunities of becoming familiar with the manner in which gas companies deal with the ammonia in gas. The removal of the ammonia from the gas is, as a rule, most successfully managed, fully 95 per cent of the ammonia existing in crude gas being extracted before the gas is delivered for general consumption. But the arrangements for the preservation and storage of the gas liquor are of the most defective character. In the pages of the *Journal of Gas Lighting* the subject of this loss of ammonia has been discussed; and I have been aware almost from the first that one of the hardest tasks laid on those who have charge of Cooper's process will be the task of arousing gas managers to an adequate sense of the necessity of bestowing sufficient care on the gas liquor.

Gain in Tar.—This gain has been observed to arise where there is no diminution either in the volume of the gas or in its illuminating power. In his presidential address to the Gas Institute Mr. Paterson mentioned that he had observed a gain of 13 per cent of tar when Cooper's process was worked. In a trial experiment on 50 tons of limed coal a gain of 6 per cent of tar has been recorded. And, lastly, a gain of 2 gallons of tar per ton of coal was noticed in a working extending over a period of six weeks, at the rate of 50 tons a day.

Diminution in the Sulphuretted Hydrogen and Sulphuret of Carbon.—I will cite an experiment which, through the kindness of Mr. P. J. Wates, I was enabled to make at the Vauxhall Works. A mixture of lime with small coal was made by taking 56 lbs. of quicklime, slaking with 5 gallons of water, and adding 1 ton of coal. Some 12 tons of limed coal was operated upon; and the gas, after passing through the condenser and the scrubber, was tested for sulphuretted hydrogen. In 1000 volumes of the gas Experiment I. gave 3·44 volumes of H_2S, Experiment II. gave 2·45 volumes of H_2S. These measurements of

sulphuretted hydrogen were made by a method described in the *Philosophical Magazine* in the year 1881; and the sulphuretted hydrogen was converted into sulphate of lead and weighed. Crude coal-gas from unlimed coals, according to my experiments, contains from 8 to 15 volumes of sulphuretted hydrogen in 1000 volumes of gas. If it is to be assumed that the Vauxhall gas from unlimed coal contains the least of these quantities of sulphuretted hydrogen, the conclusion is arrived at that, by the operation of liming the coal, the sulphuretted hydrogen had been diminished to between one-half and one-third. I have, however, to remark that the mixing was most imperfect in the above experiment. With good mixing very much better results would be got, and I should expect the sulphuretted hydrogen to fall down to 1·0 volume per 1000 volumes of gas. The diminution of the sulphuret of carbon appears to correspond with the diminution of the sulphuretted hydrogen. The fact of there being a very considerable diminution of sulphuret of carbon has been established by numerous experiments on the largest scale. Early in the present year I managed to persuade Mr. Wates to make trial of the liming process on the entire make of gas in one of the large retort-houses at the Vauxhall Works in London. The quantity of coal carbonised in the retort-house was about 1000 tons a week. The trial working began on January 8th, and with very slight intermission was continued into the month of May. During the first fortnight a little lime was brought into the retort-house, exhibited to the workmen, and then got into the retort anyhow. After the novelty had worn away attention was bestowed on using the right proportion (viz., ¼ cwt. of quicklime to each ton of coal), and on getting some kind of approach to a mixture of the materials. The actual mode of operation was of the rudest and most primitive description. The lime, slaked just as if it were to be used in the lime-purifier, was carried into the retort-house in sacks, and the contents of each sack was spread over the exposed face of the heap of coals which lay opposite to the retorts in the retort-house. When the retorts were charged, the coal, with the lime resting on its surface, was partly scraped down and partly allowed to fall down into the scoop used to charge the retorts with coal. In that manner, with the very slightest extra labour (which was paid for by the patentee), and which cost less than one halfpenny per ton of coals carbonised, a sufficient admixture of lime and coal was brought about to occasion the most striking results on the quality of the gas which was produced. As has been said, in the month of January the liming process began to be applied to the entire make of gas in one large retort-house at the Vauxhall Works. There were at that date two other retort-houses at work at Vauxhall, and these two other retort-houses were producing ordinary gas. The possibility therefore arose of instituting a comparison between Cooper's limed gas and common gas from the same quality of coal. So decisive was the superiority of the limed gas, as shown by comparative testings, that Cooper's process was soon applied to a second retort-house, and ultimately it was applied to the third retort-house; and for many weeks about 3000 tons of coal were limed before carbonisation at the Vauxhall Gas Works. In order to illustrate the action of the lime in Cooper's process the following experiments may be cited:—From the hydraulic main of one of the retort-houses in which Cooper's process was being carried on, there was a pipe which conveyed away a small fraction of the gas. This gas was cooled in a separate condenser, washed by its own scrubber, and then passed through three purifiers charged with oxide of iron, and collected in a small gas-holder. On eight different days the gas-holder was in that manner filled with gas, which was afterwards submitted to analysis by the well-known method recommended by the referees. The lowest figure for sulphur present as sulphuret of carbon was 8·7 grains per 100 cubic feet of gas, and the highest figure was 13·73. The quantity of sulphur as sulphuret of carbon in the crude gas at Vauxhall, when no lime is put into the retort, is from 30 to 40 grains per 100 cubic feet of gas. When a trifling allowance has been made for the action of the oxide of iron (about 3 grains is a fair allowance), the fall from 35 grains down to about 12 grains expresses the action of the liming process as carried out at Vauxhall.

It had therefore been demonstrated that when Cooper's process was employed the lime-purifier was a superfluity, and for a considerable period the lime-purifier was thrown out of use at Vauxhall. Those persons who are familiar with the details of the gas manufacture will be aware that in order to get the lime-purifiers to remove the sulphuret of carbon from gas many years of labour and experiment were requisite, and that even now gas managers sometimes complain that they cannot get the lime-purifiers to act. The work done at Vauxhall has shown the intrinsic superiority of the Cooper process over the lime-purifier, and I have no doubt that, with the bestowal of a little time and trouble over the details of the mixing, a far higher degree of freedom from sulphuret of carbon would be attained than can possibly be reached by the lime-purifier.

The abolition of the lime-purifier and the substitution of liming process for the use of the purifier will mark an epoch in the history of the gas industry. Hitherto a gas-works has been recognised as one of the most offensive kinds of factory in existence. When a large lime-purifier is opened the foul smell may be perceived at a distance of a mile or two when the wind is favourable, whilst in the immediate proximity of the works there arise bad smells from the gas-liquor, which is most carelessly stored. From the chimneys of the retort-houses sulphurous acid is poured into the atmosphere, to the great detriment of vegetation. By the introduction of Cooper's process all these evils will be remedied, and the gas-factory will cease to be a public nuisance.

THE VOLUMETRIC DETERMINATION OF MANGANESE.

By J. B. MACKINTOSH, E.M., New York.

In a recent paper read before the Institute on this subject, Mr. G. C. Stone advances the theory that the precipitate obtained in Williams's volumetric process,* by treating the boiling nitric acid solution of a manganese salt with potassic chlorate, is not pure MnO_2, but approximates more closely to the composition $10MnO_2+MnO$.

As the value of the process and the accuracy of our results would depend on whether this was the fact or not, it has seemed to me, and to my associates, Messrs. Beebe and Colby, that it would be of importance to ascertain the composition of this precipitate, and to that end the following series of experiments has been undertaken.

These experiments have all been based on the considerations:—

1. That potassic permanganate has an oxidising power equivalent to five atoms of oxygen for every two of manganese:—

$$K_2Mn_2O_8=K_2O\cdot 2MnO.O_5.$$

2. That the same amount of manganese in the state of binoxide has an oxidising power equivalent to two atoms of oxygen:—

$$2MnO_2=2MnO.O_2.$$

If, then, we take a solution of permanganate of unknown strength, and reduce it to binoxide, the oxidising power of the binoxide formed will be equal to that of two-fifths the quantity of the permanganate solution originally taken. While, if the precipitate obtained should not be binoxide, but an indefinite or definite mixture of bin- and mon-oxides, then, from its equivalent oxidising power, we can calculate its composition.

* *Transactions of the American Institute of Mining Engineers*, vol. x., p. 100.

The analyses were conducted in the following manner. The amount of permanganate taken was decomposed with hydrochloric acid, and concentrated to expel the excess of water. Sufficient excess of nitric acid was now added, and the solution was boiled until all the hydrochloric acid was destroyed. The manganese was then precipitated by potassic chlorate; and, after standing some time to cool—a precaution which we consider of importance—the precipitate was filtered out through asbestos, washed with nitric acid and then with water, and when perfectly clean was treated with a volume of oxalic acid, whose equivalent in permanganate was known, a few cubic centimetres of sulphuric acid being also added. The excess of oxalic acid was then estimated by permanganate, and the difference between this amount and the equivalent of the whole amount of oxalic taken gave the oxidising power of the precipitate.

To save multiplication of figures we will only give the results obtained:—

$K_2Mn_2O_8$ used.	Oxidising power of precipitate in terms of $K_2Mn_2O_8$.	Theoretical for MnO_2.	Apparent per cent of theoretical.	Corrected per cent. for burette error.
C.c.	C.c.	C.c.		
45	17·80	18	98·89	99·37
35	13·93	14	99·50	100·07
25	9·90	10	99·00	99·86
15	5·96	6	99·33	100·67

Average true per cent, 99·99

The precipitation in the above results was effected by successive alternate additions of potassic chlorate and nitric acid, until no further formation of yellow fumes were observed. Shortly after first employing the method, we noticed that the reaction was seldom complete when potassic chlorate was added during one period only, and that if, after the apparent completion of the reaction, as marked by the explosive cessation of yellow fumes, more nitric acid was added, and then a fresh portion of potassic chlorate, that the yellow fumes would reappear, again to disappear with the characteristic puff. On this account it is necessary in employing this method to add alternate amounts of nitric acid and potassic chlorate, until no further effect is produced; and, if this precaution is not observed, the results will almost invariably be low.

The next series of experiments was made to illustrate this point, and to determine the amount of error which would be incurred by exactly following the directions given by Messrs. Ford* and Williams in their respective papers, namely, by adding potassic chlorate during one period only, and boiling till the apparent cessation of the reaction. The results obtained were as follows:—

$K_2Mn_2O_8$ used.	Oxidising power of precipitate in terms of $K_2Mn_2O_8$.	Theoretical for MnO_2.	Apparent per cent of theoretical.	Corrected per cent for burette error.
C.c	C.c.	C.c.		
40	15·55	16	97·20	97·82
45	17·70	18	98·33	98·92
60	23·37	24	97·40	98·04

Showing an error of from one to two per cent.

The following determinations were made about last February, but no particular record of the details of the manipulation were preserved:—

25	9·93	10	99·30	98·34
50	19·73	20	98·65	99·07

It is evident from inspection of these results, that the first set approach very nearly to the theoretical figure for MnO_2, the average of the four happening to be 99·99 per cent. This close agreement with the theory must, however, be considered as largely accidental, as the variation in the separate determinations is quite large. In a process of this kind we must consider that the experimental errors are relatively large; indeed, larger than in the actual application of the method to analysis. These experimental errors, doubtless, balance each other to a large extent by averaging several results, as in the present instance; but we can hardly expect to get such close average results every time.

The burette was calibrated for each analysis by weighing the amount of water delivered corresponding to the various volumes used, and making proportional corrections.

Now, if the composition of the precipitate had been $10MnO_2+MnO$, as claimed by Mr. Stone, the oxidising power found should have averaged 90·91 per cent. of the theoretical figure for MnO_2, instead of that which we have actually found; so that the difference is far too great to admit of any doubt as to the true composition of the precipitate. We may safely conclude, then, that the precipitate obtained in this process, when due regard is paid to the precautions which we have indicated, is MnO_2, and not an indefinite or definite mixture of oxides, that the process is reasonably accurate, and that any estimation based upon the theory that the precipitate is not MnO_2 is of no value, because it is founded on false premises, and therefore can never be true save by accident.

* *Ibid.*, vol. ix., p. 397.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

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LEAD.

FOR the atomic weight of lead we have to consider experiments made upon the oxide, chloride, nitrate, and sulphate. The researches of Berzelius upon the carbonate and various organic salts need not now be considered, nor is it worth while to take into account any work of his done before the year 1818. The results obtained by Döbereiner† and by Longchamp‡ are also without special present value.

For the exact composition of lead oxide we have to depend upon the researches of Berzelius. His experiments were made at different times through quite a number of years; but were finally summed up in the last edition of his famous "Lehrbuch."‖ In general terms his method of experiment was very simple. Perfectly pure lead oxide was heated in a current of hydrogen, and the reduced metal weighed. From his weighings I have calculated the percentages of lead thus found and given them in a third column:—

Earlier Results.

8·045 grms.	PbO gave	7·4675	Pb.	92·8217 per cent.
14·183	,,	13·165	,,	92·8224 ,,
10·8645	,,	10·084	,,	92·8160 ,,
13·1465	,,	12·2045	,,	92·8346 ,,
21·9425	,,	20·3695	,,	92·8313 ,,
11·159	,,	10·359	,,	92·8309 ,,

Latest.

6·6155	,,	6·141	,,	92·8275 ,,
14·487	,,	13·448	,,	92·8280 ,,
14·626	,,	13·5775	,,	92·8313 ,,

Mean 92·8271 ± 0·0013

For the synthesis of lead sulphate we have data by Berzelius, Turner, and Stas. Berzelius,§ whose experiments were intended rather to fix the atomic weight of sulphur, dissolved in each estimation 10 grms. of pure lead in nitric

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Schweig. Journ.*, 17, 241. 1816.

‡ *Ann. Chim. Phys.*, 34, 105. 1827.

‖ *Bd.*, 3, s. 1218.

§ *Lehrbuch*, 5th ed., 3, 1187.

acid, then treated the resulting nitrate with sulphuric acid, brought the sulphate thus formed to dryness, and weighed. 100 parts of metal yield of $PbSO_4$.

146·380
146·400
146·440
146·458

Mean 146·419 ± 0·012

Turner,* in three similar experiments, found as follows:—

146·430
146·398
146·375

Mean 146·401 ± 0·011

In these results of Turner's *absolute* weights are implied.

The results of Stas' syntheses,† effected after the same general method, but with variations in details, are as follows. Corrections for weighing in air are applied:—

146·443
146·427
146·419
146·432
146·421
146·423

Mean 146·4275 ± 0·0024

Combining, we get the subjoined result:—

Berzelius	146·419	± 0·012
Turner	146·401	0·011
Stas	146·4275	0·0024
General mean ..	146·4262	± 0·0023

Turner, in the same paper, also gives a series of syntheses of lead sulphate, in which he starts from the oxide instead of from the metal. 100 parts of PbO, upon conversion into $PbSO_4$, gained weight as follows:—

35·84
35·71
35·84
35·75
35·79
35·78
35·92

Mean 35·804 ± 0·018

These figures are not wholly reliable. Numbers one, two, and three represent lead oxide contaminated with traces of nitrate. The oxide of four, five, and six contained traces of minium. Number seven was free from these sources of error, and, therefore, deserves more consideration. The series as a whole undoubtedly gives too low a figure; and this error would tend to slightly raise the atomic weight of lead.

Still a third series by Turner establishes the ratio between the nitrate and the sulphate; a known weight of the former being in each experiment converted into the latter. 100 parts of sulphate represent of nitrate:—

109·312
109·310
109·300

Mean 109·307 ± 0·002

In all these experiments by Turner the necessary corrections were made for weighing in air.

For the ratio between lead chloride and silver we have a series of results by Marignac and one experiment by Dumas. There are also available data by Turner and by Berzelius.

* *Phil. Trans.*, 1883, 527-538.
† Aronstein's Translation," 333.

Marignac,* applying the method used in his researches upon barium and strontium, and working with lead chloride which had been dried at 200°, obtained these results.

The third column gives the ratio between $PbCl_2$, and 100 parts of Ag:—

4·9975 grms.	$PbCl_2$ =	3·8810 Ag.	128·768
4·9980	,,	3·8835 ,,	128·698
5·0000	,,	3·8835 ,,	128·750
5·0000	,,	3·8860 ,,	128·667

Mean 128·721 ± 0·016

Dumas,† in his investigations, found that lead chloride retains traces of water even at 250°, and is sometimes also contaminated with oxychloride, In one estimation 8·700 grms. $PbCl_2$ saturated 6·750 of Ag. The chloride contained 0·009 of impurity; hence, correcting, Ag: $PbCl_2$:: 100 : 128·750. If we assign this figure equal weight with those of Marignac, we get as the mean of all, 128·7266 ± 0·013. The sources of error indicated by Dumas, if they are really involved in tnis mean, would tend slightly to raise the atomic weight of lead.

The synthesis of lead nitrate, as carried out by Stas,‡ gives excellent results. Two series of experiments were made, with from 103 to 250 grms. of lead in each determination. The metal was dissolved in nitric acid, the solution evaporated to dryness with extreme care, and the nitrate weighed. All weighings were reduced to the vacuum standard. In series A the lead nitrate was dried in an air current at a temperature of about 155°. In series B the drying was effected *in vacuo*. 100 of lead yield of nitrate:—

A.
159·973
159·975
159·982
159·975
159·968
159·973

Mean 159·9743 ± 0·012

B.
159·970
159·964
159·959
159·965

Mean 159·9645 ± 0·0015
Mean from both series 159·9704 ± 0·0010

There still remain to be noticed two sets of experiments upon lead nitrate, which were originally intended to establish the atomic weight of nitrogen. Lead nitrate was carefully ignited and the residual oxide weighed. The first series, bearing Svanberg's name,‖ gives simply the percentage of oxide found, as follows:—

67·4030
67·4036
67·4043
67·3956

Mean 67·4016 ± 0·0014

The second series is by Anderson,§ and gives the weighings upon which the percentages rest. The latter come out thus:—

5·19485	PbN_2O_6 gave	3·5017	PbO,	67·4071 per cent
9·7244	,,	6·5546	,,	67·4037 ,,
9·2181	,,	6·2134	,,	67·4044 ,,
9·6530	,,	6·5057	,,	67·3957 ,,

Mean 67·4027 ± 0·0016

* *Journ. f. Prakt. Chem.*, 74, 218. 1858.
† *Ann. Chem. Pharm.*, 113, 35. 1860.
‡ "Aronstein's Translation," 326.
‖ *Journ. f. Prakt. Chem.* 27, 381. 1842.
§ *Ann. Chim. Phys.*, (3), 9, 254. 1843.

It will at once be seen that these series are identical; the discordance between the first figures of the two being undoubtedly due to some misprint in the weighings of the Anderson set. How it happens that the same work has been published by two separate authors I will not attempt to explain; neither will I undertake to determine which of the two is really entitled to credit.

We have now seven ratios upon which to base our computations :—

(1.)	Per cent. of Pb in PbO,	92·8271 ± 0·0013
(2.)	Per cent of PbO in PbN_2O_6,	67·4016 0·0014
(3.)	Pb : $PbSO_4$ :: 100 :	146·4262 0·0023
(4.)	PbO : $PbSO_4$ :: 100 :	135·804 0·018
(5.)	$PbSO_4$: PbN_2O_6 :: 100 :	109·307 0·002
(6.)	Pb : PbN_2O_6 :: 100 :	159·9704 0·0010
(7.)	Ag : PCl_2 :: 100 :	128·7266 0·013

Discussing these separately, we get an equal number of value for the atomic weight of lead :—

From (1)	Pb = 206·587 ±	0·059
,, (2)	,, 207·046	0·041
,, (3)	,, 206·435	0·041
,, (4)	,, 207·131	0·118
,, (5)	,, 204·803	0·329
,, (6)	,, 206·454	0·037
,, (7)	,, 206·473	0·042
General mean ..	,, 206·604 ±	0·019

If O = 16, this becomes Pb = 207·079.

In the above discussion are included several values which diverge widely from this general mean, and which, for other reasons, are probably erroneous. Although but one of these carries much weight, it is as well to exclude them, and to base our computations upon the others. If, now, we reject the second, fourth, and fifth values, we get for the atomic weight of lead, Pb = 206·471 ± 0·021. If O = 16, this becomes Pb = 206·946.

From the synthesis of the nitrate Stas found 206·918, and from the sulphate, 206·934. The agreement of these values with our own general mean is certainly very close.

NOTES ON LOEW AND BOKORNY'S RESEARCHES ON THE PROBABLE ALDEHYDIC NATURE OF ALBUMIN.

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The remark of Emerson "what we know is a point to what we do not know" is very applicable to the present state of our knowledge of albumin. Professor Schorlemmer ("Rise and Development of Organic Chemistry," page 123) says, "the enigma of life can only be solved by the discovery of the synthesis of an albuminous compound." The direct synthesis of albumin from its elements has never been conducted; but we know that it consists of a very complex molecule of 225 atoms ($C_{72}H_{112}N_{18}SO_{22}$). As to how these atoms are grouped together we know nothing. Of late there has been some excellent work done by MM. Loew and Bokorny in this line of research, which opens a vast field of enquiry for the physiological chemist. They have been paving the way for the synthesis of this compound. In their researches on living and dead protoplasm they came to the conclusion that living protoplasm contains an aldehyd group of elements.* From their experiments on the living protoplasm of the fresh-water algae, *Spirogyra* and *Zygnema* growing in spring-water containing 0·1 per cent of dipotassium phosphate and ammonium nitrate, they found that the living cells had the power of reducing silver from a very dilute alkaline solution of the metal. Dead cells do not give this reaction. The authors have experimented upon the cotyledons of the sunflower (*Helianthus annuus*), the epidermal hairs of plants, the sap of the pine and oak, the cells of fruits, fungi, and also many of the infusoria, with the same result. From these observations they conclude that living protoplasm contains an aldehyde group of elements, whereas there is no such group in dead protoplasm. Reinke (*Berichte der Deutschen Chemischen Gesellschaft*, 15, 107, and 14, 2144) says that the aldehydic character as tested by an alkaline silver solution is only a property of the protoplasm of the chlorophyll, for he does not find it in the protoplasm of cells in unopened buds; therefore he thinks it is probable that it is formed only in the presence of sunlight by the chlorophyll corpuscles. Mori (*Chemisches Centralblatt* [3], 13, 563) considers that formic aldehyd is the first product of assimilation, for he detected (by the action of a solution of nitrate of silver) a substance which reduced the nitrate in plants containing chlorophyll which had been exposed to sunlight. When the same plants were left for about 48 hours in a dark place, so that on applying the test again the first products of assimilation might be used up, no reduction of silver took place. Therefore, both Reinke and Mori support Baeyer's theory that formic aldehyde is formed by chlorophyll under the influence of light from the carbonic acid of the atmosphere :—

$$\left\{\begin{matrix}CO_2 = CO + O\\ H_2O = H_2 + O\end{matrix}\right\} = O_2 + \left\{\begin{matrix}H\\ COH.\end{matrix}\right.$$

Kretzschmar ("*Biedermann's Centralblatt für Agricultur-Chemie*," 1882, 830), on the other hand, states that the protoplasm of living and dead *Spirogyra* reduces silver from an alkaline solution of the metal, and so concludes that this reagent fails to distinguish between living and dead protoplasm.

Having been working of late on the cell-contents of plants,† I have gone over a good portion of the experimental work which led Loew and Bokorny to their conclusions; and in this communication (which was the substance of a paper of mine read before the Chemical Society on June 7th last, but contains additional experiments and observations) I am desirous of detailing a few observations I have noticed in the case of *Spirogyra*. I found on treating it with a dilute alkaline solution of a cupric salt, that in the protoplasm of the living cell red cuprous oxide was precipitated, the same reaction being observed in the case of dead protoplasm. On treating the living cells of this plant with a *weak* solution of sodium chloride under the power of the microscope, it was observed that crystals were formed in the protoplasm. When the live or dead cells of *Spirogyra* are treated with absolute alcohol and allowed to stand for a few hours, needle-shaped crystals of anhydrous dextrose were formed in the cells. From these and further observations to be described presently, I am inclined to think that the body which has the reducing effect on metallic solutions is one of the glucoses, and most likely the crystals observed (when the cells were treated with sodium chloride solution) have the formula $C_6H_{12}O_6.NaCl.H_2O$ for it is well known that dextrose forms a crystalline body of this composition with sodium chloride. To confirm my observations as far as possible, I took the albumin (the white) of a newly laid egg, and mixed with it a small quantity of a very weak solution of dextrose, and then placed some of the mixture on the slide of the microscope. I now ran in the weak NaCl solution (of the same strength as used with the living and dead cells of *Spirogyra*), and after some hours standing I observed crystals exactly like those observed when experimenting with the cells of the plant. I tried also the

* "Die Chemische Kraftquelle im lebenden Protoplasma," von Oscar Loew and Thomas Bokorny.
Berichte der Deutschen Chemischen Gesellschaft, 14, 2508; and 15, 695.
Pflüger's Archiv. für Physiologie, 25, 150.

† "Chemico-Microscopical Researches on the Cell-contents of Certain Plants," by A. B. Griffiths, *Journal of the Chemical Society, Transactions*, 1883, page 195.

"copper test" and the "alcohol test" respectively on the mixture of egg-albumin and dilute dextrose, and obtained similar results to those observed in the living and dead cells of *Spirogyra*. The reduction of the copper and also of Kretzschmar's silver solutions in both the living and dead cells goes to confirm the supposition that this form of sugar is in the cells of *Spirogyra*. Futher, if the *living plant* be kept in the dark for a couple of days, no reduction of copper or silver solutions takes place, and no crystals are formed when sodium chloride solution is given to the living cells; and no needle-shaped crystals are formed with absolute alcohol. The above results may be due to the whole of the dextrose being used up in the dark, for we know that carbohydrates go to nourish the cell-wall and tissues. On exposing the plant again to sunlight for a short time, and on treating with the same alkaline cupric solution and the solution of sodium chloride, the same phenomena were observed. Schorlemmer ("Chemistry of the Carbon Compounds," page 290), considers the constitution of dextrose to be "the first *aldehyd* of the hexad alcohol mannite," from the fact that an aqueous solution of dextrose when treated with sodium amalgam is converted into mannite, and that it reduces silver and other metals from their compounds. Levulose, another member of the family of glucoses, is also considered to be an "aldehyd of a hexad alcohol," reducing silver and copper from their solutions, and by oxidation it yields glycollic acid; whereas dextrose yields gluconic acid, and ultimately saccharic acid. Cane sugar is generally looked upon as an ether. It does not reduce salts of silver and copper, and does not form crystals with sodium chloride; in fact it is not an aldehyd; both dextrose and levulose from these considerations are aldehyds. The glucose which I found when examining the living and dead protoplasm of *Spirogyra* was dextrose (right-handed glucose) and *not* levulose (left-handed glucose), for levulose does not form a crystalline compound with sodium chloride solution. Again, if levulose had been present when treating with the "alcohol test," no needle-shaped crystals would have been precipitated; for absolute alcohol does not precipitate levulose. If, as Mori thinks, aldehyde is the first product of assimilation, then I think it most probable that it is soon converted into starch, or some of its isomers, by the action of chlorophyll in the presence of light, or by leukoplastids in the absence of light. This starch or carbohydrate is ultimately used up, as is well known, in nourishing the growing tissues and cell walls; but before it is so used up I think it most likely that it is converted into dextrose, according to the following equation:—

$$C_6H_{10}O_5 + H_2O = C_6H_{12}O_6.$$

Whether an aldehydic substance is the basis of living protoplasm or not it is difficult to say, but Loew and Bokorny have certainly a large number of facts in favour of their hypothesis. What is known is that some carbonydrate is the starting point for all organic compounds. To conclude, I think such researches as these will greatly help chemists in the synthesis of albumin, or, as it has been called, "the basis of life"; such a discovery would be the greatest of all triumphs of synthetical chemistry. Someone may say "supposing albumin to be built up from its elements it will be different to that found in *living* animals and plants." I think not, as my learned master and friend, Professor Schorlemmer, Ph.D., F.R.S. ("Rise and Development of Organic Chemistry," page 122) says: "If ever chemists should succeed in obtaining albuminous bodies artificially, it will be in the state of *living protoplasm*, perhaps in the shape of those structureless beings which Häckel calls the "Monera," or as Huxley puts it in his "Invertebrata": "It must not be supposed that the differences between living and not living matter are such as to bear out the assumption that the forces at work in the one are different from those which are to be met with in the other. The phenomena of life are all dependent upon the working of the same physical and chemical forces as those which are active in the rest of the world."

PROCESS FOR THE MICROSCOPIC EXAMINATION OF WATER FOR ORGANIC IMPURITIES.

By J. BRAUTLECHT.

THE author produces a precipitate in the water by adding to 100 c.c. 5 drops of a solution consisting of one part aluminium sulphate, one part hydrochloric acid, and 8 parts water, followed up by 1 to 3 drops of liquid ammonia. The precipitate settles readily, and after decanting off the clear is collected upon a smooth filter, stroked off with a glass rod, and thus transferred to a test-tube, in which it is disolved in 10 to 15 drops of dilute acetic acid. The clear solution is examined with the microscope, at first alone, and then after the addition of a solution of saffranine. By adding ½ per cent of gelatin, permanent preparations may be obtained on Koch's principle.—*Rep. Anal. Chemie und Chem. Zeitung* (Cœthen).

NOTICES OF BOOKS.

The Practical Laboratory Guide in Chemistry. By DAVID O'BRINE, B.S., M.E., Assistant in Chemistry in the Ohio State University. Columbus, O.: A. H. Smythe, 1883.

IN compiling a book on practical chemistry, or on any other subject, the compiler may be actuated by two motives, either that of his own material benefit, or the benefit of the class of students to whom he addresses himself. To compile a work when the author is animated by the former spirit is a comparatively easy matter now that encyclopædias and dictionaries of science are so numerous, and publishers are not considered responsible for the rubbish they are the means of throwing upon the world already so heavily burdened in this respect. But to arrange facts and describe phenomena in a manner that may help a student in his conceptions of scientific ideas, and lessen his difficulties in his first essays among the mysterious intricacies of the material world, requires all the experience and judgment of a teacher long habituated to associate with pupils of all degrees of mental calibre. In our laboratories in this country we have several excellent treatises on elementary practical chemistry written by teachers who were amply qualified to undertake the task; still, in spite of the almost universal use of these few typical books, whether it arises from the defects in these text-books, or the presumptuousness of junior demonstrators, each year sees its ever increasing quota of new manuals professing to teach the principles of chemistry, but which, in the vast majority of cases, show them, upon the briefest examination, to have been compiled with apparently total ignorance of what an elementary student really does require. It is not a mere statement of facts, or the correctness of formulæ and equations brought together in a *multum in parvo* fashion, that constitute the value of a guide-book; for these statements can be worded in such terms, or the formulæ thrown together in such a higgledy-piggledy manner, that the learner might as profitably attempt to imbibe chemistry from the writings of the old alchemists, or the hieroglyphics of the Egyptians.

Among the quite recent additions to our literature we have here a laboratory guide-book, in which the first thing that attracts our notice is a long list of *errata*, which, by the way, is not nearly complete. The misprints, although not of serious importance, are such as one might expect to see in a daily newspaper, but never in a fashionable novel: as "crucibel," "analases," "pipetts," "sellenium," "venadium," "Priestly."

Glancing at the symbols that adorn the pages we are struck by the great want of uniformity in the method of writing the formulæ of many of the compounds, and a

divergence from what we are accustomed to see in our modern recognised text-books, as well as what may seem to be the introduction of a concise method of stating certain facts about the compounds. This innovation of the authors consists of a stroke written over the formula to indicate that the body is given off as a gas, and underneath it forms a precipitate. As an illustration of this new complication of matters we take the following sentence:—

"When KIO_3 is heated, $\overline{O}_3$ as $KIO_3 = KI + \overline{O}_3$."

Brackets, too, are used in a way we have never seen before, and without explanation, as—

"$2(K_2OH_2O) + 4Cl = K_2OCl_2O + 2(KCl) + (H_2O)_2$."

Chapter I., on the preparation of reagents, contains the usual instructions for making these solutions; the language in some cases, however, is vague. What does the author mean by this, under the preparation of potassium nitrite? "It will be noticed that if N_2O_3 is passed in (KHO) a nitrite is formed; but if from any reason NO_3, a nitrate will be formed; the truth is a mixture of nitrate and nitrite is formed." For our part we can "notice" nothing to indicate this strange phenomenon.

Chapter II. gives the definitions of atom, molecule, &c., which, however, are stated in far too few words, and in somewhat foggy language. From these definitions we select a few:—"A radical is the residue of a molecule, and acts like the atom, as a unit (HO) hydroxyl." But why not explain the word residue, taking such a formula as NH_4? "A binary compound is the union of two elements." "Acids are electro-negative binaries which are generally formed by the union of oxygen with non-metal." "An acid is a compound of hydrogen with a negative atom or radical; as, (HCl) hydrochloric acid, (H_2OSO_3) sulphuric acid." Now, taking these last three "definitions" together, will anyone tell us what is an acid and what a binary compound? But more extraordinary still is this one: "A reaction is representing chemical changes by their symbols"! We are accustomed to use such phrases as, "bodies react upon each other chemically," or "a chemical reaction is taking place." And what is usually meant by these expressions? In a chemical reaction—using the term in its generally received sense—or state of chemical change, is not the very mystery of mysteries of matter exhibited to our senses, and the full understanding of which the aim and goal of all true chemistry? Truly if a "reaction" be but the expression of chemical changes by "their" symbols, the symbols are as yet infinitely defective, although the author does give an example to illustrate his definition.

Chapter III., on "tests in the dry way," pleases us to see this important subject treated so fully. This seems indeed, to be the best chapter in the book. Thallium, we notice, is absent from the flame reactions, although perhaps it is more frequently met with than lithium. Some of the hints in this chapter might have been omitted; as, "If you have a solution of lead or the alkaline earths you need not look for sulphuric acid." Supposing calcium and ammonia found, on the strength of this hint would not the student omit to search for sulphuric acid?

The final parts of this book are taken up by subjects which are not usually given to a general student after an elementary course in qualitative analyses, as the analyses of water, milk, cheese, urine, and poisons; one chapter, too, is on the examination of ptomaines! If the work had been designed for the medical student only, one could understand this, but the preface tells us that "The object is to present a practical guide in chemistry adapted to the wants of the college or the medical laboratory." Yet many of the physiological facts may be of interest to the analytical chemist, and well worth remembering if he should be ever called upon to report on articles of food or drinking-waters; for example, "Bad water may effect (*sic*) the stomach and cause dyspepsia, cholera, &c."

Chapter III. of Part 6, on the laws of chemical incompatibility, we should have liked to have seen extended to a greater length, with a few examples by which we, as well as the tyro, might have benefited. Here, under "Berthollet's Law," we have eight statements, without any comment, but to make out which one is the "law" puzzles us very much. We give abstracts of the first and last:—

"1. Two salts in solution may form by the interchange of their acids and bases, two insoluble salts, which are precipitated. . . . ."

"8. The following substances are best given alone:—Hydrocyanic acid, nitro-hydrochloric acid, ... the poisonous metals combined with acetic acid, and, in general, the alkaloids."

The physiological section ends with a chapter on man, who is "nothing but six pails of water combined with twelve to fourteen pounds of solid matter," in which the data of daily waste and supply of an average man usually found in works on physiology are given. This chapter concludes with a sentence which, as appearing in a work on chemical analyses, we cannot refrain from quoting:—"In the language of my friend and teacher, Prof. Norton, 'The apparatus is a living machine governed by an immortal soul, working for itself and others. The machine finally wears out, leaving about seven pounds of lime salts to the hundred, and a memory deathless for a chosen few, weak and fugitive for the great majority. Nevertheless, life is worth living if we have the approval of a good conscience'"!

It may be that Mr. O'Brine, who is a teacher, writes this book for a select class of students whose mental constitution he is better acquainted with than we are, and is probably, therefore, a better judge of what kind of pabulum should be served up for them. Perhaps, also, as the book may prove of service exclusively in his own class-room, his disquisitions on the foggy points may render its study a pastime. Still we hope that, should a second edition be called for, we shall see a little more pains taken to ensure clearness, even at the expense of redundancy.

That the principles and facts of chemistry have been acquired by Mr. O'Brine we have no doubt, but to put these on paper requires more trouble and care than he has evidently given the matter.

Workshop Receipts. By Robert Haldane. Second Series. London: E. and F. N. Spon. 1883.

This little book, the author tells us in his preface, forms a second series of his original "Workshop Receipts," published a few years ago. The favourable reception that was given to the first compilation indicated that the author has supplied a want long felt amongst experimenters and manufacturers, and, encouraged by this success, the present volume has been written on the same pattern as the original.

By the title that is given to this book one would be inclined to expect the information to relate principally to mechanism and the mechanical arts, but instead of it being so the subjects here brought together have reference almost exclusively to the chemical trades, and probably therefore this volume may prove to be of comparatively greater utility to the chemical technologist than to the mechanician.

The contents, which are in alphabetical order, range from acidimetry to preserving, and between these two extremes we have a heap of valuable information and receipts relating to numerous subjects intimately connected with the lesser chemical industries. Under bleaching we have recipes for bleaching and decolourising albumen, coral, feathers, sponge, wax, &c. Cements and lutes, the directions for their preparation and application, forms a valuable section of the book, as the number of recipes given would seem to be sufficient in variety to be applicable to everything that is breakable and stickable from alabaster to wood and zeiodolite. Under boiler incrustations a fair synopsis is given of what is known regarding this plague, and a short critical examination of many of

the different processes that have been brought forward from time to time to remedy the evil. Cleansing, copying, dyeing, and staining pigments, essences, and extracts are fully represented by great numbers of formulæ. The mysteries of the confectioners' art, too, are explained at some length, which matter, however, seems to be rather out of place in a book of workshop receipts. Nor are such useful agents as matches, ink, glue, &c., forgotten. In many places the author gives references to the sources from which he has derived his information; this certainly may be valuable to those who wish to consult the original authorities, but merely to name the journal from which the information is derived, without giving either the date or volume, renders such references well nigh useless.

About Photography and Photographers. By H. Baden Pritchard, F.C.S. London: Piper and Carter.

Photographers, whether they belong to the professional or to the amateur class, who take up this little book of Mr. Pritchard's with the hope that, coming from such an authority on photographic matters, it may assist them over their difficulties in the production of a really artistic picture, creditable both to themselves and the makers of their apparatus, will in a certain sense be disappointed. In place of a string of rules and formulæ about exposure, lenses, developers, and such like, we have here a series of short and most entertaining essays for the studio and study, to which are added Continental rambles with a camera. The subjects of these essays are of general interest to photographers outside the operative room, and, written in a pleasant style, will afford much amusement combined with instruction to everyone who is in any way connected with the photographic art. In the first essay, "The First Camera Photograph," an account is given of M. Niépce's early struggles in making his discovery, the narrative being rendered highly interesting by short abstracts from his private letters regarding the gradual development of his process and the obstacles he had to contend with.

In the numerous essays that follow, the reader will find material which will afford several agreeable half-hours' reading. "About Medals," "Business Tact," "Photographers by Diploma," and "Publication of Photographs," may interest some of our art aspirants.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
September, 1883.

Notice of Foreign Researches in Organic Chemistry.—G. de Bechi.—Translations from the *Berichte der Deutsch. Chem. Gesell.* and the *Journal für Praktische Chemie.*

The Alizarine Industry.—Ivan Levinstein.—An abstract of a paper read before the *Society of Chemical Industry.*

Lecture on the Artificial Reproduction of Organic Matters of Animal or of Vegetable Origin.—Emile Jungfleisch.—A paper read before the *Société d'Encouragement*, and already noticed.

New Applications of Incombustible Paper and Colours.—M. Meyer.—An account of experiments showing the fire-proof character of the author's paper.

The "Gelis" Sulpho-carbometer.—This paper, which is almost an advertisement, cannot be intelligibly reproduced without the accompanying illustration.

Disinfection of Alcohols of Bad Flavour by means of Electrolysis.—Laurent Naudin.—Already noticed. It is necessary to protest against the misuse of the term "disinfection" in the title of this paper.

A Remarkable Case of Chyluria, and the Presence of Caseine in Urine.—Dr. A. Loison and E. Leger.—The urine examined is characterised by the presence of caseine, a compound not yet proved to occur in that excretion. The caseine did not appear to be derived from the blood of the patient. The same urine contained also from 3·25 to 4·11 grms. of fatty matter per litre, whilst in the blood only 2·05 grms. per litre were present. The authors give the provisional name of urocaseine to the form of caseine found, reserving the question of its identity with the caseine of milk.

Industrial Society of Mulhouse.—The Chemical Committee met July 11. M. Horace Kœchlin read the results of experiments made on the fixation of colours by means of gelatine rendered insoluble by potassium dichromate. Mineral colours and certain aniline colours are thickened with gelatin, and printed upon cloth prepared with sodium hyposulphite, and then passed through potassium dichromate. The colours bear soaping at boiling-heat, and the action of light.

M. Lussy presented a report on the theory of Turkey-red dyeing, and on the constitution of the sulpholeates.

M. Noelting gave some details on the azo- and diazo-derivatives of the cresylols.

Preparations of Ergot founded upon Recent Researches.—C. S. Hallberg.—From the *Pharmaceutical Journal.*

Uranium Oleate.—W. Gibbons.—A paper read before the Pharmaceutical Society.

Analysis of the Sulpho-carbonates.—O. Hehner and H. S. Carpenter.—From the *Analyst.*

Essence of Angelica.—Laurent Naudin.—Already noticed.

Justus Liebig's Annalen der Chemie,
Band 219, Parts 2 and 3.

Chloride of Lime and certain Analogous Bodies.—G. Lunge and P. Naef.—The authors' results are that Kraut's objections against the formula Cl–Ca–OCl, adopted by Lunge and Schäppi, are groundless. The assumption of a decomposition of calcium chloride by the joint action of carbonic and hypochlorous acids is a confusion of two reactions, which are not simultaneous but successive. Hypochlorous anhydride decomposes calcium chloride at common temperatures, liberating chlorine, and forming a mixture of chloride of lime with excess of calcium chloride, and probably a little calcium hypochlorite, but no free lime. Hydrated lithia is converted by chlorine into chloride of lithia to a much greater extent than is stated by Kraut. The chloride is not stable in presence of excess of chlorine, but is resolved into lithium chloride and free oxygen to a much greater extent than chloride of lime under similar conditions. It is, however, much less affected by carbonic acid than is chloride of lime. The behaviour of chloride of lithia differs so much from that of chloride of lime that the molecular structure of the two compounds is probably dissimilar. Products resembling chloride of lime can also be obtained from the bivalent metals, strontium and barium,—with the latter only, however, under conditions not yet ascertained.

Synthesis of Tyrosine.—E. Erlenmeyer and A. Lipp.—If to a solution of the hydrochlorate of amido-phenyl-alanine there is gradually added nitrous acid, either as nitrous anhydride or sodium nitrite, at 0°, no escape of gas takes place, but as soon as the liquid is raised to a boil much nitrogen escapes, and there remains tyrosine, either alone or accompanied with undecomposed amido-phenyl-alanine. The authors regard tyrosine as para-hydroxy-phenyl-alanine.

Derivatives of Cinnamic Acid obtained during Experiments on the Synthesis of Tyrosine.—E. Erlenmeyer and A. Lipp.—This very lengthy paper does not admit of useful abstraction.

Researches on Hydroxilation by Direct Oxidation.—R. Meyer.—The first portion of a very extensive memoir, not adapted for abridgment.

Communications from the Laboratory of the University of Würzburg.—These consist of a paper by J. Wisclicenus on methyl-β-butyl-ketone and certain of its derivatives; researches on the mono-halogenic substitution-compounds of crotonic acids, by Dr. R. Friedrich; and a continuation of the same subject by the same author.

The Position of Thallium in Chemical Systematics, and its Occurrence in the Sylvine and Carnallite of Kalusz.—Julian Schramm.—The author refers to the known fact that elements approaching each other in their physical and chemical characters occur together in nature, but that their relative quantity decreases in proportion as their atomic weights increase. Hence an element may, in doubtful cases, with great probability be referred to that group with which it is found associated. In order to decide the disputed position of thallium, he enumerates the cases in which it has been found along with alkaline metals. It has thus occurred in lepidolite, mica, in the alums of the Island Vulcano, in the salt springs of Nauheim, and in the carnallite of Stassfurth. He has examined the corresponding minerals of Kalusz, in Gallicia, and has found in carnallite, thallium and rubidium, but no cæsium. Sylvine yielded thallium, but neither cæsium nor rubidium. In kainite, thallium, rubidium, and cæsium were absent. He concludes that sodium, lithium, and cæsium occur together, whilst potassium, rubidium, and thallium form a distinct group, and that the last element should be included among the alkaline metals, as is maintained by Böttger, Mendelejeff, and others.

Cosmos les Mondes.

No. 15, August 11, 1883.

Bichromatisation.—Dr. Laujorrois.—The author recommends potassium dichromate for disinfecting cesspools, sewage, dissecting-rooms, &c., and considers it likely to be of great service in the treatment of diseases due to microbia.

Nos. 16 and 17, August 18 and 25, 1883.

These numbers contain no chemical matter.

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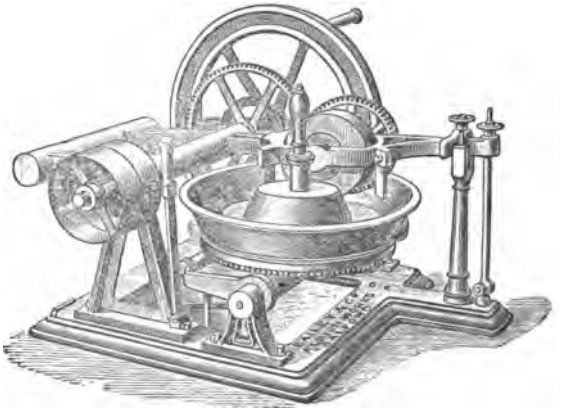

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1247.

METHODS FOR COKING COAL AND RECOVERING THE BY-PRODUCTS.*

By WATSON SMITH, F.C.S., F.I.C.

There are various forms of plant for coking coal for the production of coke for metallurgical purposes, which may be classed as follows:—

1. Those accompanied with no utilisation or recovery of the by-products.
2. Those utilising the by-products merely as fuel, burning them, but recovering no by-products.
3. Those recovering the by-products and utilising as fuel the gaseous portion thereof.

Representative Systems neither utilising nor recovering By-products.	Representative Ovens consuming Tar Vapours and Gases as Fuel, for Heating their Walls and Bottom Beds, either or both.	Representative Ovens adapted for recovering By-products and utilising the Gas for Fuel.	
		A.	B.
I. The Meiler or mound. II. The beehive oven.	I. Appolt oven. II. Coppée oven.	Admitting air, and so partial combustion of the coal. — Jameson's oven.	closed ovens. Destructive distillation. — Knab's oven. *Pauwells and Dubochet's. Pernolet's. Simon-Carvès's.

* Illuminating gas was made at Paris by this method, the tar and gas-liquor being recovered.

There are many other forms of oven, but I have only referred here to the representative systems, and I do not propose to enter into any detailed description of the development, construction, and working of all these ovens, but after the briefest sketch of the development from the more elementary forms, of the two most improved modern representative forms, to deal with these as regards the results obtained more especially, in more detailed fashion.

Meiler, or Mound.—The Meiler, or mound, closely resembles the well-known Meiler constructed for producing charcoal from wood, and needs no further remark save that the coke obtained is good and freer from sulphur than oven-coke, owing to the desulphurising action of the steam derived from the moisture at the base of the Meiler. The ground at the base of the Meilers for this reason is often kept damp in order that moisture may be absorbed. The Meiler coke is not so hard as oven-coke.

Beehive Oven.—The Beehive oven, which yields a metallurgical coke that can scarcely be surpassed, wastes all the gas and by-products generated, and the verdict by almost all English coke makers till recently has been that it is impossible to condense by-products without sustaining a depreciation of the quality and value of the resulting coke. Even now there are many who will not hear of any attempt at recovery of by-products being made, regarding such recovery as an unerring blow struck at the quality of the coke.

Appolt Oven.—Although, however, the collection and recovery of condensed by-products were deemed inadmissible, yet to some of the more far-sighted there seemed no reason why these by-products, containing latent, vast possibilities of heating effect, should all pass up the oven chimneys as half-burnt gases and smoke, disfiguring the landscape and damaging vegetation—and hence the invention and construction of the forms of oven named after Appolt and Coppée. The principal feature in the construction and working of the former is that, instead, as in the Beehive oven, of the flames and half-burnt gases and smoke passing up a flue through the centre of the dome into a main flue, and so passing to the chimney, the hot gases and tar vapours distilled from the coal in the closed oven pass into numerous circulating side flues, surrounding and enveloping the inner case of the oven. Into these side flues air is admitted, its admittance being suitably regulated, and so perfect combustion and a high heating power are secured. The bottoms of the Appolt ovens are composed of movable plates secured by screw and cross-bar, and thus the coke produced is readily removed. This oven yields an excellent coke.

Coppée Oven.—The Coppée oven resembles Appolt's, but the gases and vapours descend from an aperture in the upper part of the oven by vertical flues heating its sides, and supplied with air by means of suitable apertures to insure complete combustion to flues passing under the oven bottom, which the flames strongly heat. A main flue then often carries the hot gases to do further duty in heating steam boilers, &c., before they finally pass to the chimney.

It will now be necessary to proceed to consider the development of two of the best systems of ovens now existing with combined recovery of by-products, from certain of those forms of ovens which were originally combined with no appliance or apparatus for recovering the by-products. I mean the Jameson oven developed from the Beehive form, and the Simon-Carvés from the Knab's oven.

Jameson's Coke Oven.—Jameson modifies the common beehive oven in the following way:—He substitutes for the usual solid floor of the oven on which the coal is carbonised, a floor of perforated quarles supported on sleeper walls, these perforations being connected with a short vertical flue underneath the floor, from which a pipe passes at right angles towards the hydraulic main situated some little distance from the ovens. A branch thus proceeds to this main from each oven in a battery of ovens, and just before entering the main the down-pipe from each branch is furnished with a cock for regulating or stopping the exhaustion on the oven at discretion—this exhaustion being carried on as is usual in gas-works. It is stated that the "heating gas produced can be conveyed to a distance and used in heating, and raising steam"—this gas not being employed in aiding the coking process itself. Now, if the results be good, we have in this arrangement of Jameson's at least promise of no great expense in construction, for Mr. Jameson proposes simply to put in his new floors to beehive ovens, and then simply add the condensing and aspirating apparatus. Whether this can be done effectively or not, or whether, having pulled up the old floors and further modified the dome, it will not prove best to renovate the whole oven, to prevent air being too liberally sucked in, will be a question to be settled by practical experience. If Mr. Jameson's estimate of cost be correct, and this cost do average "£20 per oven for perforated floor, piping, and proportion of condensing scrubber and exhauster," then it cannot be said this cost is excessive; but the qurstion now to be answered is, What is to be the outcome? What does this tar consist of, and of what value are the constituents? What yield of ammonia is obtained? &c.

1. The coke is good, and is readily accepted by iron-masters, but so is the Beehive coke.

2. As regards the ammonia, this is collected and condensed as ammoniacal liquor, which I am told contains a good deal of the ammonia as sulphite. This must be due to the effect of the air drawn into the Jameson oven. Jameson says he can obtain ammoniacal liquor equal to a production of from 5 to 15 lbs. of ammonium sulphate per

* A Paper read before the British Association, Section B, Southport Meeting.

ton of coke, =3 to 9 about, per ton of coal. A wide difference truly, and betokening some want of certainty.

3. The tar, as it was at first called, is now, I observe, termed "oils," and Jameson states that he obtains six to fifteen gallons of tar per ton of coal coked. As to this tar, various reports have got abroad. In the *Journal of the Society of Chemical Industry* it has been represented in one case as consisting merely of paraffins, liquid and solid, and in another as containing no aromatic compounds applicable to the manufacture of colours. Now neither of these statements is quite true, although in part so. Though benzene is quite absent in the Jameson tar, yet in admixture with paraffins, both very small quantities of toluene and larger quantities of xylene are present. I have obtained their nitro-products. Now benzene, toluene, and, I believe, xylene, have been found in the Scottish shale spirit produced in the works of the Young Paraffin Light Co. This I proved at least to be the case in 1868. But these aromatic hydrocarbons were mixed in the shale spirit with bodies of about the same vapour tension, belonging to the olefiant gas series, and the attempt to convert them into their corresponding nitro-derivatives resulted in the production of bodies yielding most acrid and pungent fumes, resembling those of acrolein. Besides rendering the operation of nitration intolerable, the acrid bodies were not easily removed from the nitro-benzene and its homologues. But in the spirit from the Jameson oils the bodies present belong to the marsh-gas series mainly, and hence the aromatic hydrocarbons present might be safely nitrated, and the paraffins afterwards removed by steam from the crude nitro-products. The unfortunate circumstance is that there is so little of this benzene series present, and the representative member (benzene) was quite absent from all samples I have yet examined.

Lubricating or Burning Oils.—The chief bulk of the Jameson tar, having a specific gravity of 0·960, consists of oils boiling between 250° and 350° C., from which on cooling no crystalline substance separates. These oils I have tested as regards their burning qualities in lamps, and as regards lubricating value, and I find them of little value for burning, and of but secondary value as lubricants. One singular feature about them is that they are quite devoid of "blueness" or fluorescence. If these oils find their way into the market, I would give a timely warning to all those who are buyers of vegetable and animal oils, viz., cease to rely solely on the test of "blueness" or fluorescence of the oils you examine, as a proof of the presence in them of mineral oils!

Paraffin.—But a considerable proportion of oils distils over above 350° C., viz., from somewhere about 400° to the point at which pitch remains in the retort, and these oils do separate paraffin scale, though not so much as could be desired, and the paraffin wax obtained has a high melting-point, viz., 58° C. It is characteristic of the solid paraffin obtained (of course in small quantity) from certain normal coal-tars, especially those obtained from Wigan cannel, that this paraffin possesses a very high melting-point. The highest melting-point of the paraffin wax made by the Scottish shale distillers is about 52° C.

Phenols.—If the crude oils boiling between 200° and 300° C. be treated with caustic soda-lye, and the phenols extracted in the usual way, a fairly large proportion of a peculiar series of phenols of increasing boiling-points is obtained in the crude extract, certain of these phenols resembling the constituents of the creosote of wood-tar. A mere trace of carbolic acid was found, but more of the cresols, and by far the largest bulk of the constituents of the crude phenol, distils at from 250° to 300° C. The latter fraction boiling at about 300° is a resinous substance perfectly soluble in caustic soda, to which it communicates a red colour.

Certain of these phenols yield blue and red colours with alkalies, but of no stability or value. These coloured alkaline salts remind one of the coloured salts of eupittonic acid, the phenol-like acid derived by the oxidation of Reichenbach's wood-tar pittacal.

Neither naphthalene nor anthracene is present even in traces in Jameson's coke-oven tar. The fact that the specific gravity of this tar is less than that of water is a circumstance sufficient of itself to indicate that it belongs to the class of tars obtained by the distillation of coal at lower temperatures. I think that Jameson's coke-oven tar offers a fine field of research to the scientific chemist, and that his labours *may* develop valuable fruit in a commercial sense, as well as for science; but I do not consider this tar at present, looking at its heterogenous nature, a very inviting subject for present commercial speculation, in view of the possibility of getting the far more valuable real coal tar as a coke-oven by-product, with its colour-yielding and purely aromatic constituents.

I have here to thank Mr. H. L. Pattinson, jun., of Felling, on the Tyne, for his kindness in supplying me with tar from the Jameson process, with which process he has been experimenting, also for furnishing me with a large supply of the crude phenols.

Closed Ovens.—We will now turn to the next species of ovens, viz. the closed oven, in which a purely destructive distillation takes place. The best of this class is decidedly the Simon-Carvès oven, and I think I can show that it does its work perfectly. The Simon-Carvès oven is a lineal descendant, so to speak, of the Knab's oven, which was the first coke-oven with which a process for the recovery of by-products was combined. The ovens of Pauwells and Pernolet were intermediate steps in the right direction. In what direction, then, did these steps tend? In the direction of a more elevated temperature, and this advance involved continual improvements in construction, so as to secure the attainment of increased distilling temperatures. In the Simon-Carvès oven employed at Messrs. Pease's work at Crook by Darlington the temperature attained is 2200°, but in the recently improved recuperative ovens a temperature of 3000° may be reached at the point of actual combustion. Although Knab's oven, first started in 1856, and furnished with side and bottom flues for the combustion of the oven gases, but not recovering by-products, was afterwards modified for such recovery by M. Carvès himself, and was thus a step in the right direction, it was merely so in being a closed oven, not as regards the temperature, for the tar yielded was not yet of the right kind. Of the still more improved methods of Pauwells and Dubochet used at the Paris gasworks, and of Pernolet, we read, as regards the tars produced, in the treatise on Coal-tar Distillation by my friend Professor Lunge, of Zürich, these tars "differ to some extent in composition from the ordinary gas-tar, and quite naturally, since in the case of the former the temperature has been much lower." The temperature being "much lower" means the introduction of paraffins into the tar, and the paraffins mean the comparative ruin of any anthracene that may be formed. It means, moreover, the probable absence of naphthalene in the tar, and admixture with the members of the benzene series of lower paraffins or olefines. It was thus M. Carvès who first (by a modification of Knab's oven) devised and constructed a coke oven designed for the recovery of tar and ammonia.

I have had the opportunity some two or three months ago, of inspecting the Simon-Carvès ovens and plant at work in Crook, at Messrs. Pease's West Collieries, and Mr. Dixon, the manager, kindly supplied me with a quantity of tar and coke obtained in the process. The ammonia liquor is of good strength, 6°—7° T, and is sold to a tar distiller in Middlesbrough, on the usual terms for gas liquor. Let us now examine the plans of the Simon-Carvès oven, and see by what means the high temperature already referred to is attained. These ovens are joined to exhausting, condensing, and scrubbing apparatus, quite similar to that found in the system employed in gas-works.

I observed on inspecting the tar-well at Messrs. Pease's work, that its walls, and the inside of the man-hole edge,

were lined with a sublimate of naphthalene, and the tar possessed the smell and appearance of the tar from ordinary gas retorts. Now this sublimed naphthalene indicates that the condensing and cooling power are very deficient, and as I expected, the density of the tar was high, for no doubt much of the uncondensed benzene and toluene had been carried off with the gas and burnt in the ovens.

The Tar.—The Carvès tar is quite different, both in appearance and specific gravity, from Jameson's. Its specific gravity is 1·20, and it is black and thick, and smells quite differently from the Jameson product. The former sinks, therefore, at once in water, whilst the latter floats on its surface. In composition the tar from the Carvès ovens closely resembles the tar produced in the large London gasworks, *i.e.* it is exceedingly rich in naphthalene and anthracene, but less rich than some tars, *e.g.* the Lancashire tars, in benzene, toluene, xylene, and carbolic acid, but these it contains as richly as any London tar. It is, moreover, quite free from paraffins. This great difference in the Simon-Carvès tar from Jameson's is due to the fact that in the production of the former a close oven, a very high temperature, and a rapid distillation are adopted, just as is the case in the gasworks. I said that a good deal of benzol in the Simon-Carvès process as carried on at Pease's, must pass with the fuel gases into the oven-furnaces again, and so be burnt. Now I should like to indicate what might be done further, in addition to improved condensation, and no doubt will be done, and so place the Simon-Carvès process quite beyond the reach of its rivals.

Mellor's Process for recovering Benzol as Nitro-benzol.—A process has been patented recently by Mellor, of Patricroft, for abstracting the benzol from gas, by washing the latter with strong nitric acid in an earthenware tower filled with broken glass. The nitro-benzol formed is an oily body, in which benzol itself is soluble, and so the acid mixed with nitro-benzol from one washing, and strengthened with sulphuric acid, can be passed down the tower again and again, and no benzol is lost through insufficiency of acid, for when the acid is exhausted, the nitro-product produced dissolves out benzol. This benzene (the toluene is quite easily nitrified) can be then removed by steaming, with subsequent condensation. Thus both benzene and nitro-benzol might be obtained, though Mellor merely refers to "benzol."

Davis's Process.—Mr. G. E. Davis, of Manchester, has patented a process for refrigerating coal gases, and washing the gases so refrigerated, with refrigerated heavy coal-tar oils, by which he extracts all the benzol present. By a subsequent wet steam distillation, the benzol is recovered, may be rectified, and sold.

Let either of these or similar processes be grafted on to the Simon-Carvès process—say at Messrs. Pease's—and let them extract and manufacture their own tar products and sulphate of ammonia, and extract the rich store of anthracene in their tar for the alizarin manufacturers, and I think they will be tempted by the profitable results ensuing to speedily convert all their numerous batteries of beehive ovens into Simon-Carvès ovens, and so turn what are at present waste gases and smoke into hard cash.

But now comes the question as to the coke. Attempts formerly made to obtain valuable tar by-products in variously constructed ovens generally resulted, as we have said, in the obtaining, according to report, bad coke for blast-furnace use. How is it to be explained, then, that the coke obtained in the Simon-Carvès process is as coherent, solid, and massive as could be desired, and yet the tar is identical with that obtained in gas-works retorts, where a coke is made of little value to the ironmasters?

In the Simon-Carvès ovens, a very large charge, 4½ tons of coal, is used, and this is piled up to a considerable height, some 6 feet or so. The thickness of the mass is also considerable (about 19 inches), but not so great that the heat of the oven sides cannot penetrate it with sufficient ease to give a uniform product. Now as in the retorts of the gasworks, the mass soon attains a caked condition, but being thicker, and hence being penetrated more slowly, it attains a more thoroughly caked or pasty stage than the thinner mass on the gas-retort bottoms can do before beginning to set again, in the incipient coked stage of the process. But further, in the Simon-Carvès ovens, the superincumbent weight of a pasty mass of some 6 feet in height introduces a new and important factor in the production ultimately of a hard, solid article—the semi-fused fuel maintained in a soft condition to a late stage by the high temperature of the Simon-Carvès ovens becomes thus pressed by its own weight, and sinking down, gives, on cooling, a hard, solid mass. Finally, from so huge a charge as 4½ tons, and charred under a certain gaseous pressure, and with a thickness of material proportionately considerably larger than is found in gas retorts, I believe that during the escape of the tar vapours from the decomposing mass, a portion of these must suffer almost complete coking, the pores of the mass becoming thus filled up, the yield of coke increased, and more solidity being thus conferred upon it—another function of the high temperature of the ovens.

In the ordinary metallurgical coking process with the behive oven, and in a less degree with the Jameson process, we have a kind of partial combustion or oxidation effected in whch the oxygen of the air admitted or drawn into the ovens plays a part, the hydrogenised portions of the coal being to some extent burnt away, but in the closed Carvès ovens purely a case of destructive distillation ensues. It is not to be greatly wondered at that the appearance of the coke obtained in Simon-Carvès ovens is somewhat different then from that obtained in the bee-hive and Jameson oven, not possessing the silvery glance of the latter, though at least being fully as solid, hard, and compact. Mr. Dixon, Messrs. Pease's manager, told me moreover that some of their customers who had taken both kinds of coke (the bee-hive and the Simon-Carvés) from them, preferred the latter, the new kind, and wished to be supplied with it entirely.

I feel quite sure that the process of M. Carvès, so intimately associated with the oven of his develoment and construction, will be the coking-process of the future, and that anything done to extend its right appreciation and make known the great possibilities it offers will be a service to this country.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.*

By H. BRERETON BAKER.

In two papers read before the Chemical Society in 1880, and in one read before the Royal Society in 1881, Mr. Stillingfleet Johnson announced that he had caused the two elements nitrogen and hydrogen to unite directly, and that he had discovered that nitrogen could exist in two allotropic modifications. His views did not meet with general acceptance among chemists. It was thought that a little more of the light of experiment might be thrown upon this subject. This I have endeavoured to do.

I will, with your permission, first describe briefly the mode of experiment adopted by Mr. Johnson:—

The hydrogen was generated by the action of sulphuric acid on zinc; the nitrogen, by warming an aqueous solution of ammonium nitrite. The two gases were passed through a wash-bottle of silver nitrate solution, and through two of strong sulphuric acid. They then bubbled through some Nessler's solution contained in a set of Liebig's bulbs, were passed over red-hot platinum sponge contained in a piece of combustion tubing, and, lastly, through another set of Liebig's bulbs containing Nessler's solution. The production of ammonia in the tube containing the spongy platinum would be recognised by the

* A Paper read before the British Association, Section B, Southport Meeting.

colouration of the Nessler in the second set of bulbs, while that in the first remained colourless. Now Mr. Johnson observed the production of comparatively large quantities of ammonia. He was able to estimate it by bubbling the gases through standard sulphuric acid, and found it amounted to about 6 m.grms. an hour. He tried to get the same result by using nitrogen obtained from the air by passing it over red-hot copper. No ammonia was produced! He explained this by supposing that nitrogen can exist in two allotropic modifications, one of which is capable of direct union with hydrogen, and the other not. He supposed that the nitrogen from the air had lost its activity by being exposed to a red-heat.

In the second paper read before the Chemical Society he expresses some misgivings as to the purity of his "active" nitrogen. It is well known that towards the end of its decomposition ammonium nitrite gives off considerable quantities of oxides of nitrogen. These, if not removed, would enter into reaction with hydrogen under the influence of spongy platinum, forming ammonia. Mr. Johnson accordingly modified his apparatus. The nitrogen, obtained by the decomposition of ammonium nitrite, was passed through four absorbers containing ferrous sulphate solution. At this point a three-way tube was inserted, and the hydrogen (previously *purified* by passing through a solution of silver nitrate) was introduced into the apparatus. The mixed gases were passed through two wash-bottles containing ferrous sulphate, through one of alkaline pyrogallate, through one of sulphuric acid, through the first Nessler's solution, over the heated platinum sponge, and through the second Nessler's solution.

By using these absorbers of nitric oxide the production of ammonia was diminished to 3 m.grms. an hour. This experiment demonstrates, therefore, that *half* the ammonia produced in the first experiment was due to the presence of oxides of nitrogen. I venture to think that my experiments will show that the whole of it may be accounted for in the same way.

Mr. Johnson suggested that the nitrogen of the air lost its activity by being exposed to a red-heat. I attempted to prepare active nitrogen by exposing cold phosphorus in a bell-jar suspended in a deep vessel of water. When the absorption of oxygen was complete the bell-jar was lowered into the vessel of water, and the nitrogen driven into a gas-holder. The hydrogen was prepared by the action of dilute sulphuric acid on zinc. It was freed from arsine and stibine by passing it through two cylinders filled with marbles which were soaked in a strong solution of potassium permanganate. The two gases were passed together through three wash-bottles of pyrogallate of potash, through one of sulphuric acid, through tube I. of Nessler's solution, over the heated platinum sponge, and through the second tube of Nessler. In this apparatus there was no possibility of the entrance of the oxides of nitrogen. Three experiments were made. In two of them the gases were passed for an hour and a half, the platinum sponge being heated to low redness. In the third the gases were passed for two hours, the platinum being heated for an hour and a half to a dull redness by a Bunsen's lamp, and during the last half hour the gas blowpipe was applied to get a higher temperature. In none of these experiments was there the slightest difference perceptible between the colours of the Nessler's solutions I. and II. It may be concluded, therefore, that nitrogen obtained from the air by absorption of the oxygen with phosphorus does not unite directly with hydrogen under the influence of platinum sponge.

Several other experiments were made with a simpler kind of apparatus. The spongy platinum was placed in the shorter arm of an inverted U tube. About 20 c.c. of air, contained in this tube, were allowed to stand over a solution of potassium pyrogallate for eighteen hours. When the absorption of oxygen was complete the tube was transferred to a dish of pure water, and the solution of pyrogallate contained in the tube allowed to diffuse into the water. This process was repeated until the contents of the tube were colourless. A pellet of metallic sodium was held beneath the open end of the tube until the volume of hydrogen added was about thrice that of the nitrogen originally contained in the tube.

The part of the tube containing the platinum sponge was heated. In all the experiments a decrease of volume of the gases was noticed. This seemed to indicate chemical union. By means of a bent pipette some Nessler was introduced into the tube, and owing to the peculiar bend in the tube the test solution could be shaken in the gas without wetting the platinum sponge. No colouration of the solution was produced; it was therefore considered that the decrease in volume was due to occlusion of hydrogen by the platinum. In another series of experiments the mixture of nitrogen and hydrogen was obtained by warming the platinum sponge in a mixture of 3 volumes of hydrogen and 1 volume of air. In no case was any indication of ammonia observed.

Allow me now to point out where Mr. Johnson's error arose. After getting a purely negative result with this apparatus, I introduced a flask of silver nitrate between the third bottle of pyrogallate and the bottle of sulphuric acid. The gases were passed for fifteen minutes. No alteration took place in Nessler I.; a distinct precipitate formed in Nessler II. The introduction of the nitrate of silver had caused the formation of ammonia.

On reference to Mr. Johnson's apparatus it will be seen that, after using elaborate precautions to ensure the freedom of his nitrogen from oxides of nitrogen, he introduces the same impurity with the hydrogen. He has, however, three absorbers of nitric oxide between the bottle of nitrate of silver and the platinum sponge. To ascertain whether these would be sufficient to remove the source of error, I arranged the following experiment:—Hydrogen, purified as before by potassium permanganate, was passed through a solution of silver nitrate, through three bottles of saturated solution of ferrous sulphate, through one bottle of strong sulphuric acid, through Nessler's solution I., over heated platinum sponge, and through Nessler's solution II. The gases were passed for three-quarters of an hour, on three separate occasions, and in each case a distinct brown colouration was observed in the second Nessler's solution.

In addition, the solution of nitrate of silver was blackened, silver having been deposited, and the first wash-bottle of ferrous sulphate showed a darkening in colour, presumably from the absorption of nitric oxide. It may be considered either that the absorbers are not sufficient to remove all the nitric oxide produced by the decomposition of silver nitrate, or, as seems more probable, some other oxide of nitrogen, not absorbable by ferrous sulphate, is produced in that decomposition. In either case we see where the error of Mr. Johnson's experiments lies. The ammonia was produced by the action of hydrogen on an oxide of nitrogen. We may therefore come to the conclusion that hydrogen does not unite directly with nitrogen under the influence of heated spongy platinum, and, as far as our present evidence goes, nitrogen does not exist in two allotropic modifications.

Joint Action of Potassium Dichromate and of the Halogens upon Organic Matters.—M. l'Abbé Godefrey. In this preliminary memoir the author states that instead of oxidising organic bodies with a mixture of potassium dichromate and sulphuric acid he has substituted for the latter reagent chlorine, bromine, and iodine. He has obtained not merely oxidised organic derivatives, but oxyhaloid derivates and certain compounds of chromium. On treating aniline in this manner with iodine he obtains mauveine, a small quantity of a beautiful red matter; long, slender, crystalline needles, extremely flexible, and an insoluble precipitate of a fine black, containing chromium.—*Bull. de la Soc. Chim. de Paris.*

AN APPARATUS FOR RAPID GAS ANALYSIS.*

By ARTHUR H. ELLIOT.

In many manufactories and metallurgical works it is often of great service to be able to make rapid analyses of the gases resulting from various operations, as these analyses serve to control the operations and indicate the progress of the processes. This is especially true for iron and steel works, where a knowledge of the composition of the gases from a furnace is an index of the character of the changes going on inside the furnace. Such rapid analyses are also often needed in gas-works. To meet this requirement of technical works, many methods have been devised and various ingenious forms of apparatus have been constructed. But all the appliances used for this purpose have been based upon the principle of absorbing the various gases in a mixture by liquid reagents. Of the many methods of using liquid reagents that of Orsat is probably the best known, and the one that has been most used. In this apparatus the gas, after being measured, is made to pass into vessels containing the liquid reagents, and so arranged as to expose a large surface, wet with the reagent, to the mixture of gases. If time is of little value, this apparatus works very well, but it is too slow in its action to be desirable for use in technical works. One great objection to the apparatus itself is the number of stop-cocks attached to the various parts of it. These stop-cocks become incrusted with the various reagents and refuse to turn without great trouble; and any force applied to them is apt to cause a fracture, which ruins the apparatus for further work until the damage is repaired.

Instead of passing the gas into a vessel containing the chemical reagents, Raoult† put the reagent into a tube containing the gas. In treating a mixture of gases with several reagents, it is necessary to remove one reagent before adding another. This is accomplished by washing out with water in such a manner that the gas is not lost. Raoult performed this treatment of the gases and washing out of reagents in a graduated tube with two stop-cocks, one at each end; one of the stop-cocks was surmounted with a funnel to introduce the fluids. But the whole affair was not easily managed, and the gases were submitted to an unnecessary amount of washing while removing the excess of reagents used.

Wilkinson modified this method, and devised a very simple and useful apparatus, in which the clumsy manipulations of Raoult were overcome by using a tube with one stop-cock above, the lower end of the tube dipping into water in another tube of much larger diameter. By this means the gases could be treated with liquid reagents, introduced through a funnel attached to the stop-cock above; and by introducing or removing water from the outer tube the gas could be measured at atmospheric pressure. To facilitate the removal of liquids from the outer tube, the latter has a stop-cock attached below. But, as in the apparatus of Raoult, the gases are submitted to an unnecessary amount of washing when water is introduced to remove the reagents. This washing becomes very important in many cases. For example take the case of illuminating gas. We introduce potassic hydrate solution to remove the carbonic acid, then potassic pyrogallate to remove oxygen; and now we must wash out the alkali before adding bromine to absorb the illuminants. To do this, much water is needed, and this large quantity of water will wash out some of the illuminates, often as much as two per cent.

To overcome this difficulty of excessive washing, I have devised the apparatus which is the subject of this paper. In this process, the gas is removed from the absorbent liquid and measured in another vessel, without washing.

The apparatus is shown in Figure 1. The tube A is of about 125 c.c. capacity, whilst B, although of the same length, holds only 100 c.c. from the point D, or zero, to the mark on the capillary tube at C, and is carefully graduated in 1-10th c.c. The attachments to these tubes below

FIG. 1.

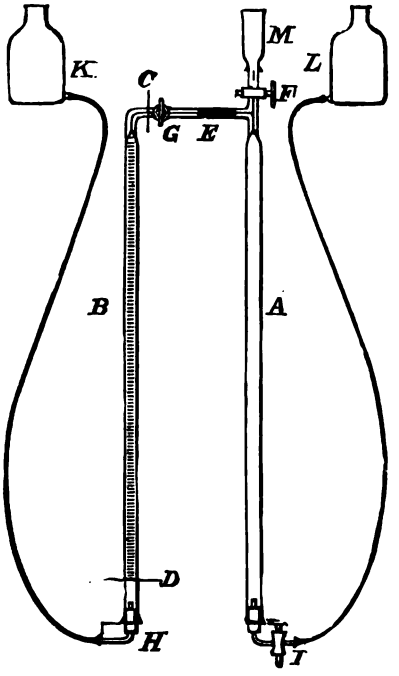
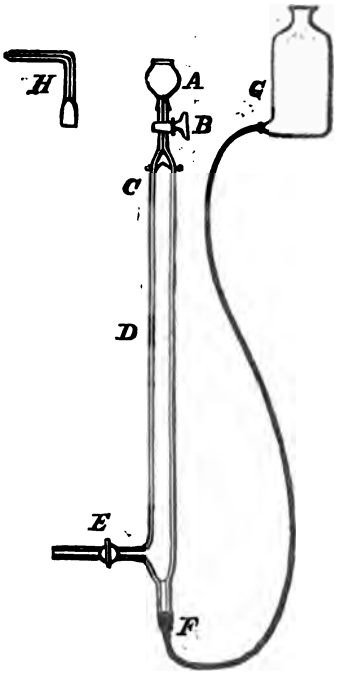


FIG. 2.



* From the *Annals of the N. Y. Academy of Sciences*, vol. ii. No. 12, 1883.

† F. M. Raoult, *Comptes Rendus*, 1876, 84.

three-way and has a delivery through its stem. The bottles K and L hold about a pint each. The tubes A and B are connected above with one another, and also with the cylindrical funnel, M, by a series of capillary tubes about one millimetre in diameter inside. There is a stop-cock at G and another at F, while the funnel M, which holds about 60 c.c., is ground to fit over the end of F above. At F is a piece of rubber tubing uniting the ends of the capillary tubes, which are filed square to make them fit as closely as possible.*

In beginning the analysis of a mixture of gases, the stem exit of the three-way cock I is closed by turning it so that L and A are connected through the rubber tubing; the stop-cocks F and G are opened, and water is allowed to fill the apparatus from the bottles K and L, which have been previously supplied.

When the water rises in the funnel M, and all air-bubbles have been driven out of the tubes, the stop-cocks F and G are closed, the funnel M removed, and the tube delivering the gas attached in its place.† By now lowering the bottle L slowly, and simultaneously opening the stop-cock F, the tube A is nearly filled with gas, and the stop-cock F is closed. The tube delivering the gas is removed, the funnel M replaced, the bottle L raised, the bottle K lowered, and by opening the stop-cock G, the gas is transferred to the graduated tube B.

The bottle K is now adjusted so that the level of the water in it is the same height as the zero-mark D on the graduated tube. By means of the bottle L, the gas is adjusted to the zero-mark D in the graduated tube, and the stop-cock G is closed.

The excess of gas in A is expelled by opening the stop-cock F and raising the bottle L. The gas remaining in the capillary tube between C and the vertical part is disregarded, or its value may be ascertained and an allowance made; but usually it is too trifling to be worth notice.

Having measured the gas, it is now transferred by means of the bottles K and L into the tube A, and the fluid chemicals added by placing them in the funnel M and allowing them to flow down the sides of the tube A slowly, care being taken *never* to let the fluids run below the level of the top of the vertical tube in the funnel. It is best to have a mark on the outside of the funnel at least three-fourths of an inch above the tob of the level of the vertical tube, and never to draw the fluid down below this point.

Having treated the gas with the chemical, it is transferred by means of the bottles to the tube B, to be measured. If the chemical gets into the horizontal capillary tube, the passage of a little water from the bottle K will remove it, before transferring the gas. When the gas residue is in B, and the fluid of A has been adjusted at the mark C on the horizontal tube, the stop-cock G is closed, the bottle K is lowered till the level of liquid in it and and in the tube B are the same, and the reading is then made. The tube A is now filled with the chemical just used as absorbent, and water; by turning the stem of the three way-cock I, so that it communicates with A, and is open below, and by also opening the stop-cock F, the contents of the tube can be run out, and water added through the funnel M to clean the tube for a new absorption. When the tube is clean, by turning the stop-cock I, so that A and L are connected, the water is forced into A, and the whole is ready to receive the gas in B for new treatment.

In using the apparatus, the chemicals are added in the following order:—

1. Potassic Hydrate (1 in 20) to absorb carbonic acid. If illuminating gas is under examination, a very little of the reagent will be necessary, and it is better to use a solution of potassic hydrate of four times the above strength, in order to prevent washing out of the illuminants. For traces of carbonic acid, and also for the determination of sulphurous acid and sulphuretted hydrogen, special methods are necessary.

2. Bromine, to absorb illuminants. This is added to some water placed in the funnel. It is best handled with a very small pipette, since only a few drops are necessary. Add it till the tube is filled with its vapour; then absorb the vapour with potassic hydrate used for carbonic acid.

3. Potassic Pyrogallate, to absorb oxygen. Solution of potassic hydrate (1 in 8), containing about three per cent of pyrogallic acid.

4. Cuprous Chloride, to absorb carbonic oxide. This is a solution (1 in 4) in concentrated hydrochloric acid. After using it, and *before* transferring the gas to the measuring tube, a little water is added to absorb the acid vapours.

By this method, a mixture containing carbonic acid, oxygen illuminants, and carbonic oxide, can be analysed in from twenty to thirty minutes, according to the amount of practice the operator has had with the apparatus.

Compared with Orsat's process, the work can be done with the above-described apparatus in one-fourth the amount of time, and with identical results.

The water used in the apparatus should have the same temperature as the room in which the analysis is made; and by careful handling, little or none of the chemicals get into the bottle L. When working in a warm place, the tube B should be surrounded with a water-jacket to prevent change of volume in the gas while under treatment.*

Having added the above absorbents, the residue of gas may consist of hydrogen, marsh-gas, and nitrogen; and for the determination of these I have devised a simple form of explosion-burette, shown in Figure 2. It consists of a burette, D, of heavy glass, graduated in tenths of cubic centimetres, and holding 100 cubic centimetres to within about two inches of the lateral tube, E, below; the upper end is closed by a stop-cock, B, over which fits a funnel, A, in the same manner as in the apparatus described above. The graduations on the tube are made so that the stop-cock is the zero point, and the 100 mark is below, near the lateral tube E.

Into the upper end of the burette, at C, are fused two platinum wires for an ignition spark. At the lower end of the burette, the glass is drawn out to receive, at F, a piece of soft rubber tubing about three feet long, which in turn communicates with the aspirator bottle, G. Care should be taken that the opening of F and the tubulature of the bottle, G, are not smaller than the bore of the rubber tubing used to connect them, since any contraction would prevent the cushioning of the explosion when the spark is passed.† The bent piece, H, is ground to fit over the stop-cock, B, when the funnel, A, is removed, and facilitates the transfer of the gases from the absorption-burette before described, as it is easier to slip a piece of rubber tubing over the smooth end of H than over the ground end of the stop-cock, B. The stop-cock, and also the fitting, H, have capillary tubing of about one millimetre bore. The stop-cock at F, and its tube attaching it to the burette, are of ordinary size, about 1-8th to 3-16ths of an inch.

The operation of the burette is as follows:—

The funnel is removed from the absorption-burette of the previously described apparatus, and a fitting exactly like H is substituted for it. The gas should be previously transferred to the measuring tube of the absorption-apparatus. The explosion-burette is placed in a vertical position in a stand near the absorption-apparatus. The bent tube on the upper stop-cock of the absorption-apparatus is now

* The height of the apparatus can be diminished by having bulbs at the points of union of the capillary tubes and the absorption and measuring tubes A and B; such bulbs being of about 25 cubic centimetres capacity, and the graduations continued downwards from the bulb on the tube B. Making the funnel spherical also reduces the height of the apparatus.

† A tube of the same construction as is shown in the explosion-burette figure can be attached to the end of the stop-cock, and thus facilitate the attachment of the rubber tubing.

* Whenever possible, it is better to collect the gas in tubes and transfer it to the apparatus in a position away from sources of heat.

† It is also most important that the clamp holding the burette should not hold too tightly, as pressure upon the glass will cause a fracture on exploding the gases. It is better to use a spring clamp.

attached to a piece of rubber tubing long enough to reach to the corresponding bent tube of the explosion-burette. The aspirator-bottle, G, is filled with water, and by raising it and opening the stop-cock, B, and closing E, the explosion-burette is filled with water, including the bent tube, H, fitted over the end of the stop-cock, B. By a similar movement of the aspirator-bottle attached to the absorption-apparatus, the corresponding bent tube and its rubber tube are also filled with water. Care should be taken that the water completely expels all air-bubbles from the capillary tubes and the rubber tube. The explosion-burette is now attached to the absorption-burette by means of the rubber tubing already filled with water, by slipping this rubber tubing over the bent tube of the explosion-burette; taking care to exclude all air-bubbles when making the attachment. To facilitate the connecting of the bent tubes and the rubber tubing, the ends of these tubes should be drawn out so that the rubber tubing will easily slip over them.

Having connected the explosion-burette with the absorption-apparatus in the manner described above, we are now ready to transfer the gas-mixture for the explosion. For this purpose, the three-way cock of the absorption-apparatus is turned so that the bottom of the absorption-tube is closed. By now opening the stop-cocks above on the absorption-apparatus, and also on the explosion-burette, and by moving the aspirator-bottles, any desired quantity of gas can be transferred from the absorption-apparatus to the explosion-burette. When the proper quantity (about 18 or 20 cubic centimetres is sufficient) of gas has been transferred, the stop-cocks of the absorption apparatus are closed, also the stop-cock of the explosion burette. By means of the aspirator-bottle, G, the level of the water is adjusted so that the gas is at atmospheric pressure, by bringing the level of the water in the aspirator-bottle to the same height as that in the explosion-burette. This gives the correct reading of the quantity of gas used. We now have to mix this gas with the proper quantity of oxygen to cause an explosion on passing a spark through the wires, C. This oxygen is admitted through the stop-cock, E,—most conventently from a gas-holder or cylinder under pressure. Having added the proper quantity of oxygen (about equal in volume to the gas used),* the correct volume of the mixture thus obtained is read off in the same manner as that of the original gas. But before the final reading is made, the burette is removed from the stand, and by a few movements from vertical to horizontal positions, the gases are mixed, and any oxygen that collects in the tube, E, is removed to the bulk of the gases in the upper part of the burette. Having taken the final reading of the mixture, the upper part of the tube is tapped slightly to dislodge any water adhering to the platinum wires, and the spark from an induction coil is passed between them, the aspirator-bottle being below the level of F, in order to expand the mixture. A sharp click is now heard, and the tube is allowed to stand so that the heat of the explosion may pass away before reading the contraction. When the tube is cool, the reading is taken by lifting the aspirator-bottle as before. This reading gives the contraction, and by removing the bent tube and replacing the cylindrical funnel, A, the carbonic acid resulting from the explosion may be absorbed with potassic hydrate, as in the absorption-apparatus, the readings always being taken after adjusting the levels of the liquids in the burette and the aspirator-bottle.

When removing the bent tube and attaching the cylindrical funnel, care should be taken that the air in the capillary tube of the stop-cock is removed. This is accomplished by attaching the funnel, putting into it a little potash solution, and then inserting a piece of thin copper wire into the capillary tube of the stop-cock; by this means the air-bubbles are readily removed. Like the absorption-apparatus previously described, this explosion-burette is intended for rapid work where some accuracy is sacrificed to the saving of time. It has the great advantage that the explosion can be made over water—the long piece of rubber tubing acting as a cushion to the shock. I have used this burette for over a year, and with the most satisfactory results. It is only intended to be used with mixtures of gases, containing hydrogen, marsh-gas, and nitrogen,—the other ordinary constituents being determined in the absorption-apparatus.

The following formulæ are used in calculating the results of the explosion of a mixture of hydrogen, marsh-gas, and nitrogen, or hydrogen and nitrogen.

Let C = Contraction. D = Carbonic Acid: then,—

$$\frac{2C - 4D}{3} = \text{Hydrogen}$$

and D = Marsh-gas.

In the case of hydrogen and nitrogen the above formula becomes simply—

$$\frac{2C}{3} = \text{Hydrogen.}$$

These calculations give the quantities of the above gases found in the number of cubic centimetres of gas-residue used in the explosion; it is of course necessary to calculate these upon the total amount of residue left in the absorption-burette. The nitrogen is found by adding together the figures for the other constituents of the gas and subtracting their sum from 100.

The subjoined table illustrates the character of the mixtures of gases that can be analysed with the above described apparatus.

Carbonic acid	3·4	7·3	0·0	0·7
Illuminants	—	—	6·3	15·6
Oxygen	0·0	1·0	0·3	1·5
Carbonic oxide	40·2	29·8	6·0	8·5
Hydrogen	44·9	55·8	—	13·0
Marsh-gas	—	0·0	—	33·8
Nitrogen	11·50	6·1	—	26·9

With care, and a little practice with the apparatus, results are obtained within a few tenths of a per cent. of the truth, and this at an immense saving of time over the older methods of analysis—the results answering every ordinary purpose in gas and metallurgical works. After some practice, a complete gas-analysis, using the absorption-apparatus and explosion-burette, can be made in less than an hour.

School of Mines, New York.

* If the gas mixture contains little or no nitrogen, it is better to add half the volume of oxygen and one volume of atmospheric air, to moderate the force of the explosion.

NOTICES OF BOOKS.

General Properties of the Phenols (Propriétés générales des Phénols). By Dr. Jules Ville. Paris: G. Masson.

We have here a monograph of the phenols. The author arranges them in four orders; the phenols of the benzol group, those derived from the styrol group, the derivates of diphenyl, and of phenanthrene.

Their physical properties are next discussed and an account is given of their "syntheses" and their formation from the benzols. The author next treats of the chemical properties of the phenols, distinguishing such as are due to the aromatic nucleus upon which the phenolic hydroxyl is fixed, those which result from the phenolic function itself, and those which consist in coloured reactions still unexplained. In a fourth chapter he considers the analogies between the phenols and the tertiary alcohols. He comes to the conclusion that the lines of separation which have been established between the phenolic function and the alcoholic function are disappearing one by one, whilst all new data tend to connect—it may almost be said to identify—these two classes of compounds in one and the same function.

In his last chapter Dr. Ville reviews the physiological action of the phenols. Their poisonous action is a most interesting fact if we consider that at least one of them, ordinary phenol, the most poisonous of the group, is normally present in the human organism, and must, indeed, be viewed as a product of the pancreatic digestion of the albumenoid matters and of their decomposition in the intestine. This single fact overthrows the so-called qualitative theory of poisons, which asserts that whatever is poisonous in large doses is poisonous also in the smallest, the difference being merely in the extent of the injury.

This thesis may be pronounced a clear and serviceable monograph.

Pocket Book for Chemists and Metallurgists (Taschenbuch für Chemiker und Hüttenleute). Issued by the Association "Hutte." Berlin: Ernest and Korn.

THIS work is edited by the "Hutte,"—an association of chemists and Metallurgists—and does not bear the name of any author. We are told that some years ago the wish was felt for a work analogous to the "Engineers' Pocket Book," and which should give in a condensed form the most important methods, rules, and results of chemical science and metallurgical art.

The plan thus conceived has been carried out with great care, accuracy, and thoroughness. The "Pocket Book" is in fact an exceedingly convenient manual of reference, not merely for the student, but especially for the practical specialist.

The first and second sections of the book treat of mathematics and mechanics, giving a variety of tables and formulæ.

In the third we find physical information; rules for taking the specific gravities of solids; determination of the specific gravity of fluids by means of the pyknometer, of communicating tubes, of Mohr's balance and the areometer. Then follow directions for finding vapour densities, tables of the specific gravities of the elements and their salts; of sundry solids technically important; of metals in various conditions and of kinds of wood, and of gases and vapours. Next we come upon a comparison of hydrometer scales, tables of the proportion of actual hydrochloric acid at different specific gravities, according to Uhr and Roth; similar tables for nitric acid according to Kolb, and for sulphuric acid by Bineau, Kolb, and Kohlrausch; for aqueous sulphurous acid according to Scott, and for acetic acid by Oudemanns; Gerlach's tables for solutions of tartaric and citric acid; Gerlach's table for liquid ammonia, for potassa, soda, alkaline carbonates, sodium chloride, potassium, ammonium, barium, calcium, magnesium, zinc and tin chlorides; similar tables for the more important bromides, iodides, nitrates, sulphates, potassium chromates, lead acetate, ferro- and ferricyanides. Then follow tables of the solubility of salts in cold and boiling water. Next we find thermomettic tables, reduction of the degrees of the mercurial thermometer to those of the air thermometer, the expansion of solids, of liquids and gases, boiling- and melting-points; boiling-points of saturated solutions, freezing mixtures; tension of watery and mercurial vapours, heat liberated by combustion; and specific heats.

The purely chemical portion of the book begins with Mendelejeff's periodic classification of the elements, followed by a table showing their symbols, valences, atomic, molecular, and combination-weights, equivalents, specific and atomic heats. Next come an abstract of the fundamental laws of chemistry, a table of the molecular weights and percentage composition of a number of the most important bodies; rules for preparing and testing reagents; the behaviour of bodies with reagents in the moist way; a systematic course of qualitative analysis; tables or blowpipe analysis, both qualitative and quantitative; instructions for volumetric analysis; tables for calculating the results of quantitative analysis, and a summary of the methods of ultimate organic analysis.

We have next a section on spectroscopic analysis, with an account of the absorption spectra of the principal dyewares of blood, and of solutions of the earths and metals.

Then follow mineralogical tables giving the chemical composition, crystalline form, cleavage, hardness, specific gravity and form of occurrence of each species.

The last and most extensive section is devoted to chemical technology. The work here treats first of sulphur, then of the manufacture of sulphuric acid and nitric acid, the potash industry of Stassfurt, the salt-trade, the production of hydrochloric acid, salt-cake, soda, the ammonia-soda process, chloride of lime, Weldon's and Deacon's processes for generating chlorine, soaps, ammonia and ammonium salts, alum prussiate, ultramarine, potassium chlorate, borax and boracic acid, iodine, bromine, the dry distillation of wood and coal with their products; the manufacture of ether, aniline, chloroform, glycerin, oxalic and phthalic acids, resorcin, the sulphocyanides, stearine, tartaric acid, carbon disulphide, explosives, artificial manures; the technology of glass and earthenware, of paper, beet-root, sugar, and betose, the starch manufacture, beer, alcohol, acetic acid and vinegar, glue, animal charcoal, phosphorus; the gas manufacture; the art of dyeing, including the inorganic and organic colouring matters. Metallurgy is next discussed with a particular notice of the processes of industrial gas analysis.

In an appendix are given the weights and measures of different countries; an abstract of the German patent law, adulteration law, and laws regulating the respective duties of employers and servants.

We think the impression produced on the mind of every one who examines this book carefully will be astonishment at the quantity of useful matter which is here compressed together. In the laboratory of any chemical manufactory it will save, in a short time, many hours and much trouble employed in turning over works of reference.

It may, perhaps, be maintained, on the principle of the division of labour, that there are certain portions which concern the engineer rather than the industrial chemist.

CORRESPONDENCE.

THE PROBLEM OF LIFE.

To the Editor of the Chemical News.

SIR,—Mr. Griffith's communication in the CHEMICAL NEWS, vol. xlviii., p. 179, emphasises a question which is frequently put by chemists of the rising generation—Where are we to look for a plain statement of the reasonable ideal of our science in regard to life?—And it does so by prominently reproducing, as worthy of unqualified adoption, the utterances of two of the most distinguished of our scientific men, upon this important theme; whereas, I venture to say, they offend in point of looseness and dogmatism in so obvious a manner, that no one of ordinary clearness of vision could do otherwise than question them. Let them speak for themselves. Prof. Schorlemmer says: "If ever chemists should succeed in obtaining albuminous bodies artificially, *it* will be in the state of living protoplasm, perhaps in the *shape* of those *structureless* beings which Häckel calls the *Moneva*." And again: "*The enigma of life can only be solved* by the discovery of the synthesis of an albuminous compound. All attempts hitherto made for the purpose of *producing spontaneous* generation have (therefore) necessarily failed."

The italics and arrangement of the sentences are my own.

Prof. Huxley says, and the statement is taken by Mr. Griffiths to be generally equivalent to the preceding:—"It must not be supposed that the differences between living and not living matter are such as to bear out the assumption that the forces at work in the one are different

from those which are to be met with in the other. The phenomena of life are all dependent upon the working of the same physical and chemical forces as those which are active in the rest of the world."

What Prof. Huxley means, if I might venture to interpret, is that matter with its quantum of energy is the same all the world over, whether in living or not living bodies. But *can* it be *asserted* that there is no agency operating in living matter, subject, of course, to this conditioning essence of all matter, distinct from the forces at present known to us as energising in inanimate matter?

It is not my intention to enter into this controversy. These things have been spoken *ex cathedra*; can they be maintained, I would ask, upon the common human platform of enquiry into the problem of life?

As I have no desire to obtrude my personality into these questions, I retire behind the convenient symbol

X.

SELENIUM IN HYDROCHLORIC ACID.

To the Editor of the Chemical News.

SIR,—With regard to the yellow colour of raw hydrochloric acid, allow me to say a few words.

There is another substance besides ferric chloride that causes the colouration: this is selenium.

A sample of tower acid was sent here for examination, from a neighbouring alkali works, where pyrites is used. It was of a yellow to a yellowish-red colour, and had a slight red deposit at the bottom of the bottle. On treating a little of the acid with potassic chlorate, it became quite colourless. This might lead to the supposition that the colour was due to organic matter. To settle this point a fresh portion of the sample was taken, washed, and a little sulphurous acid added; a copious red precipitate was obtained, indicating the presence of selenium. A portion of the precipitate was heated on platinum foil; it gave the characteristic smell, gave no luminous flame, and left no residue. The non-luminous flame showed the absence of organic matter. When the precipitate was filtered off, the filtrate was colourless, also showing the absence of organic matter. A carboy of tower-mud was then obtained, the selenium in which was oxidised by means of potassic chlorate into solution, and the residue filtered off. The selenium was then re-precipitated by means of stannous chloride as a flocculent, easily settling mass, and after washing was drained on a filter.

No doubt the pyrites was a source of the selenium. As selenious acid, it was carried into the chambers, and by means of the vitriol into the salt-cake pot, and hence to the condensers, together with the hydrochloric acid gas. The sulphurous acid gas, a little of which is always contained in the pan gas (formed by the action of the sulphuric acid on the pan), reduces the selenious acid to selenium (the cause of the slight red deposit in the bottle).

This proves that the colour of the raw hydrochloric acid was due to the selenium, and that iron is not always the cause.—I am, &c.,

W. B. HART.

Ardwick Bridge Chemical Works,
Manchester, Oct. 9, 1883.

The Liquefaction of Oxygen and the Solidification of Carbon Disulphide and Alcohol—S. v. Wroblewski and K. Olszewski.—The authors obtain a temperature low enough for the congelation of carbon disulphide and alcohol, and for the liquefaction of oxygen by allowing liquid ethylene to boil in a vacuum. The temperature produced depends on the perfection of the vacuum. The lowest point reached by the authors was −136°. At −135·8° oxygen liquefies under a pressure of 22·5 atmospheres. Carbon disulphide solidifies at −116°, and absolute alcohol at −130·5°.—*Journal für Praktische Chemie.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 12, September 17, 1883.

Qualitative Detection of Manganese in Commercial Zinc, in Zinc Ash, and Calamine, and Detection of Bismuth in Commercial Lead by means of Electrolysis.—A. Guyard.—The author has found that the zinc of commerce contains almost invariably appreciable traces of manganese. Zinc ash, a mixture of zinc oxide, and finely-divided metallic zinc, is much richer in manganese than the metal. There is also in this ash an accumulation of iron, copper, lead, and other non-volatile impurities of zinc. To detect the presence of manganese it is necessary to saturate the ash or calamine with dilute sulphuric acid (equal vols. of the mono-hydrated acid and of water). The mixture is let stand a little, without filtering, and submitted to electrolysis, taking care to use a negative pole of copper or brass, and a positive pole of platinum. In a few moments the positive pole is surrounded with a splendid rose-violet halo of permanganic acid, whilst the negative pole is covered with a brilliant layer of metallic zinc. For detecting manganese in commercial zinc a rather large quantity of the metal is melted in a crucible at the lowest possible temperature so as to allow ash to form; the crucible is skimmed, and the manganese is sought for in the scum as above directed. For the detection of bismuth, if we electrolyse a rather strong solution of pure zinc sulphate with a negative pole of platinum and a positive pole of lead, after a time the lead becomes thickly coated with lead peroxide; if the metal contains bismuth, this dissolves, and is precipitated with the zinc at the negative pole. The copper, always present in commercial lead, traverses the liquid in the same direction, so that if the precipitated zinc is dissolved in dilute sulphuric acid, there remains a black sponge, in which it is easy to detect the presence of copper and bismuth by known methods.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Part 1, No. 12, 1883.

Contributions to a Knowledge of the Oxides of Manganese.—Odin T. Christensen.—An extensive and very elaborate memoir, not capable of formal abstraction. The author shows that pure manganese oxide is so decomposed by dilute nitric acid that exactly half the manganese enters into solution, whilst the other half remains as manganese peroxide. Acetic acid has very little action upon ignited manganese oxide, the strength of the acid being indifferent. Ignited mangano-manganic oxide is the less attacked by acetic acid the higher the degree of concentration. Manganic oxide, Mn''''_2O_3, is rightly classed with the oxides of the iron-aluminium group.

Chemico-critical Passages.—H. Kolbe.—A criticism of the views of Prof. Baeyer on isatine, in which the author asks what is the exact meaning of an "internal anhydride."

Mercury Fulminate.—A. Ehrenberg.—Aqueous hydrosulphocyanic acid does not act upon mercury fulminate as does hydrochloric acid, but there are formed mercury sulphocyanide, ammonium sulphocyanide, and carbonic acid. Ammonium and potassium sulphocyanides decompose mercury sulphocyanide in the same manner as the alkaline chlorides.

Liquefaction of Nitrogen and Carbon Monoxide.—S. v. Wroblewski and K. Olszewski.—These gases are less readily liquefied than oxygen, resisting a temperature of 136° and a pressure of 150 atmospheres. But if the

pressure is gradually released, though so as not to fall below 50 atmospheres, both nitrogen and carbon monoxide are completely liquefied.

Antiseptic Properties of Carbonic Acid.—H. Kolbe.—The author showed last year that carbonic acid has a remarkable power of preserving beef from putrefaction. He finds now that this observation was anticipated in Hermstädt's "Systematischer Grundriss der Allgemeinen Experimental Chemie," p. 162, a work published in 1791.

Preparation of Nitro-phenetol.—A caution against heating the sodium salts of the two nitro-phenols in an autoclave with aqueous solutions of the salts of the ethereo-sulphates.

Justus Liebig's Annalen der Chemie,
Band 220, Parts 1 and 2.

Investigations on Hydroxilisation by Direct Oxidation.—R. Meyer.—The author concludes that "tertiary hydrogen atoms," and as it appears, only such, can be converted into hydroxyl by direct oxidation.

Molecular Volumes of Liquids.—R. Schiff.—In this memoir, which is to be concluded, the author summarises the results obtained by Kopp, Thorpe, and Brühl. He then proposes a method for determining the specific gravities of liquids at their boiling-points, the requisite apparatus being described and figured. By this method he has found the molecular volumes of a number of fluids, chiefly hydrocarbons.

Communications from the Laboratory of the University of Würzburg.—These consist of a paper by A. K. Miller on pyrocatechin-carbonic acids and iodo- and oxy-salicylic acids; a memoir by J. Heckmann on dinitrophenyl-acetacetic ester; a discussion of the influence of the asymmetric carbon atom upon the ethans derived from active amylic alcohol, by F. Just; and a paper by K. Bauer on certain transformations of the tertiary alkyl-iodides.

Communications from the Chemical Laboratory of the University of Lemberg.—These comprise memoirs by Dr. Lachowicz on certain hydrocarbons of the methan series and their derivatives, and on the constituents of Gallician petroleum, which appears to contain an entire series of aromatic hydrocarbons, the methylated derivatives of benzol being especially present.

On Maltose.—A. Herzfeld.—The author examines the composition of the salts of maltose, and raises the questions whether it is a simple anhydride of glucose; whether, like saccharose and glucose, it is capable of forming double salts with certain haloid compounds; and whether maltose, when oxidised by means of bromine, and the product decomposed by treatment with silver oxide, forms dextronic or gluconic acids, or some other acid.

Cosmos les Mondes.
No. 1, September 1, 1883.

This number contains no chemical matter.

No. 2, September 8, 1883.

Sleeping with the Head Northwards.—A number of phenomena are brought forward to prove the influence of terrestrial magnetism upon animal life.

Researches on the Spheroidal State of Bodies.—M. Boutigny.—A notice of the fourth edition of M. Boutigny's book. The author is said to have anticipated Deville's discovery of dissociation, and to have maintained on physical grounds, as far back as 1842, that Mars must have at least two satellites.

Combination-heats of the Soluble Compounds of Lead.—Dr. D. Tommasi.—The author gives the combination-heats of lead bromide, nitrate, formiate, acetate, and glycolate, as determined experimentally, and as calculated according to the law of the thermic constants of substitution. The author calls attention to the discrepancy presented by the formiate and the acetate, in which the theoretical results are too low.

New Researches on Nitrogen Iodide—A. Guyard.—From the *Comptes Rendus.*

No. 4, September 22, 1883.

This number contains no chemical matter.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome xiii., No. 3, 1883.

Petroliferous Strata of Central Europe.—L. Piedbœuf.—Topographical descriptions and geological speculations on the origin of the petroleum beds.

The Inflammable Nature of the Gases evolved in the Diffusion of Beet-roots.—L. Chevron.—The gases in question consist largely of hydrogen.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Recovery of Sulphur from Spent Oxide.—Could any of your readers give me any information or instructions how to recover the sulphur from spent oxide used in the manufacture of coal-gas, by washing it with bisulphide of carbon? and also give a brief description of the plant necessary to produce it on a large scale. I have searched various books, but cannot find any reference to it. Are there any publications to be got treating upon this subject?—A. S.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1247.

THE INVESTIGATION BY MEANS OF PHOTOGRAPHY OF THE ULTRA-VIOLET SPARK SPECTRA EMITTED BY METALLIC ELEMENTS AND THEIR COMBINATIONS UNDER VARYING CONDITIONS.

Drawn up by Professor W. N. HARTLEY, F.R.S.E., &c.

The Disappearance of Short Lines.—It was shown in a former report of this committee (Southampton Meeting), that the spectra of metallic solutions were the same as those from metallic electrodes, line for line, in most cases even short and weak lines being reproduced. The principal difference observable in the two spectra was a lengthening of the short lines when spectra were taken from solutions, so that discontinuous lines became long or continuous lines.

A few instances of short lines disappearing have also been noticed, but such disappearances occurs only when the lines are so short, mere dots in fact, that no solution can contain a quantity of the metal sufficient to yield an image of them, unless the rest of the spectrum be greatly over exposed. Certain very short lines in the spectrum of zinc are an example of this. Very short lines in the spectrum of aluminium were not reproduced by solutions of the chloride unless the solutions were highly concentrated. It may thus be seen that the quantity of metal present in the compound thus determines the presence of these lines.

The Lengthening of Short Lines.—It was remarked that in certain cases metallic electrodes showed a different spectrum according to whether the spark was passed between dry or wet electrodes. Thus it was pointed out that when iridium electrodes are moistened with calcium chloride, discontinuous lines, which are very numerous in this spectrum, become continuous, and on further examination into this matter it has been found that even moistening with water has the same effect. Hence the supposition of which there seemed some possibility, but no proof, that a chloride of the metal was formed was found to be untenable. The very short lines in the spectrum of zinc were lengthened by the action of water upon the electrodes. It has now been proved beyond doubt that this peculiar variation in the spectra is caused by the cooling action of the water upon the negative electrode, which in effect is the same as a strengthening of the spark, since by heating the electrodes a reverse action is the result.

Alterations in the Spectrum of Carbon.—As already stated in the previous report, graphite electrodes have been generally employed for the purpose of producing spark spectra from solutions. A portion of the work in connection with this subject included an investigation of the effect of water and of saline solutions in varying the spectrum of carbon. It will of course be readily seen that, as carbon is capable of combining with oxygen and nitrogen, that different spectra might be obtained by making one or other of these gases the atmosphere surrounding the electrodes, but it is not so easy to explain why graphite points should give two different spectra in air when dry, and a third spectrum when moistened with water, the same spark conditions being maintained. Three such spectra have been photographed, but without the aid of maps their peculiarities are not capable of exact description. The maps which were drawn were presented to the Royal Society together with a communication on this subject three months since, so that they are not at present available. It may be said, however, that the difference between the spectra taken from dry electrodes in air consists in the omission of a certain number of the less refrangible lines, which have undoubtedly been identified with carbon.

Spectra of the Non-Metallic Constituents of Salts.—A long series of experiments has been made with the subject of determining the non-metallic elements which are capable of yielding spark spectra when in combination with the metals. Chlorides, bromides, iodides, sulphides, nitrates, sulphates, selenates, phosphates, carbonates, and cyanides yield nothing. On the other hand, solutions in hydrochloric acid of arsenites, arseniates, and antimoniates yield spectra of arsenic and antimony respectively. Borates and silicates in solution yield very characteristic spectra of the non-metallic constituents, but if the solutions be prepared from sodium salts the lines of the metal do not appear in the case of borates, and only the strongest line of sodium ($\lambda = 3301$) can be observed in the spectrum of silicates, even when concentrated solutions are used. These are the first spectra of boron and silicon obtained from metallic salts. Their lines are the following:—

BORON. Wave-lengths.	SILICON. Wave-lengths.
3450·1	2881·0
2497·0	2631·4
2496·2	2541·0
	2528·1
	2523·5
	2518·5
	2515·5
	2513·7
	2506·3
	2435·5

In Messrs. Liveing and Dewar's* map of the carbon spectrum, and in the list of the carbon lines, and in the map of the iron spectrum,† a number of lines are given which are absent from the photographs of the spectrum of graphite published in the *Transactions of the Royal Dublin Society* and in the *Journal of the Chemical Society*.‡ Many hundreds of spectra taken between graphite poles have failed to show a trace of these lines, and as the spectra have been photographed under very varying conditions it is scarcely likely that the lines in question are really carbon lines. They have now been identified with the spectrum of silicon. The following are their wave lengths:—

LINES FROM THE CARBON SPECTRA (Liveing and Dewar).		SILICON (Hartley).
Spark.	Arc.	Spark.
—	2881·1	2881·0
2541·0	—	2541·0
2528·2	2528·1	2528·1
2523·6	2523·9	2523·5
2518·7	2518·8	2518·5
2515·8	2515·8	2515·5
2514·0	2514·1	2513·7
2506·3	2506·6	2506·3
	2478·3	—
	2434·8	2435·5

From this it appears that in the spectrum of the arc, carbon yields but one line in the ultra-violet, wave-length 2478·3.

The Spectrum of Beryllium.—The researches made for the purpose of this report have been useful in furnishing

* Report of Committee consisting of Professors Odling, Huntington, and Hartley (Secretary). Presented to the British Association, Southport Meeting.

* *Proc. Roy. Soc.*, vol. 33, p. 403.
† *Phil. Trans.*, vol. 174, Part I., 1883.
‡ Vol. 41, p. 90.

evidence leading to a determination of the probable position of beryllium amongst the elements. It has been proved that the spectrum of metallic solutions are identical with those of the metals themselves, and it is therefore obvious that characteristic spectra may be obtained from concentrated solutions of nitrates or chlorides when metallic electrodes are not procurable just as is the case with visible spectra. It was resolved to photograph the spectrum of beryllium as obtained from its chloride in order to observe the character of its lines and the manner of their grouping. The following were the lines observed:—

Spectrum of Beryllium.

Wave-lengths.	Description.
3320·1	Strong, sharp.
3129·9	Very strong, extended.
2649·4	Strong, sharp.
2493·2	Strong, sharp.
2477·7	Strong, sharp.

The first two numbers differ slightly from those given in the *Journal of the Chemical Society*,* but they are believed to be the more accurate. The previous measurement of the lines of beryllium were two given by Thalén† with wave-lengths 4487 and 4575, and two lines very close together given in Cornu's Map of the Solar Spectrum, wave-lengths 3130 and 3130·4. It will be observed that in the spark spectrum only one line corresponding to the first of the solar lines is observed, viz., that with wave-length 3129·9. There is probably a difference in this case between the arc and the spark spectra, because there is no difficulty in distinguishing between two lines differing by 0·4, are under various conditions two lines have never been observed at this point in the spark spectrum. On the other hand such differences are by no means unusual.

Regarding the views held by Emerson Reynolds, Nilson, and Petterson and Brauner on the subject of beryllium, there may be a want of harmony in detail, but they at least agree in assigning a value not greater than 13·8, and not less than 9·2 to its atomic weight. The former number implies that the metal is a triad, the latter that it is a dyad. In the former case it must belong either to the series of elements of which aluminium, gallium, and indium are members, or to a sub-group of rare earth metals to which yttrium and scandium belong. In attempting to accommodate the element with a position in either series we are met by a serious difficulty, namely, that not only is the atomic weight not in keeping with the periodic law (a point which cannot be discussed here), but its spectrum is altogether different from the spectra typical of either class. There is a periodic variation in the spectra of the elements as well as in their atomic weights and chemical properties, and we cannot put the periodic law out of mind in considering the position of beryllium. Now the spectra typical of the triad group, of which aluminium and indium are the first and third terms, consist of three pairs of lines harmonically related, the intervals between the individuals of each pair increasing with increased refrangibility of the rays in each spectrum, while the intervals between the individuals in each pair in different spectra increases with the increase of atomic weight. The interval between each pair of lines contains an isolated ray. As the atomic weight of beryllium is less than that of aluminium it should have a spectrum in which the same grouping appears, but the intervals between the pairs of lines should be shorter, and the individuals of each pair should be closer together. The lines of beryllium are not characteristically grouped like those of aluminium and indium; it cannot therefore belong to this series of elements. If we attempt to classify beryllium in a manner which accords with Nilson and Pettersson's views‡ the elements scandium and yttrium, with atomic weights 44 and 89 respectively, must yield spectra typical of the series, and the similarity between the spectra of the two metals beryllium and scandium must be as close as that between scandium and yttrium. Now Thalen's spectra of scandium and yttrium, though both totally unlike the spectrum of any other element, have many characters in common.* Both spectra contain highly characteristic groups of lines in the orange and yellow regions, the lines or bands degrading towards the red, and the number of lines which have been measured are no fewer than 103 and 90 respectively. From these two spectra, that of beryllium is entirely different, as well in the character and grouping as in the number of the lines. Of the remaining rare earth metals at present known cerium is a tetrad, didymium is a pentad, and lanthanum a triad; their spectra are quite dissimiliar from that of beryllium. In consideration of these facts it is impossible to classify the spectrum of beryllium along with the spectra of the rare earth metals of the triad group.

Let as now consider the question of the dyad groups. On the assumption that beryllium has an atomic weight of 9·2, there is no difficulty in placing it at the head of the second series of elements, in which position it stands in the same relation to the sub-groups magnesium, zinc, cadmium, and calcium, strontrum, barium, that lithium occupies with regard to sodium, potassium, rubidium, and copper, silver, mercury. Its position is also similar to that of boron and of carbon, in relation to the triad and tetrad metals.

The spectra belonging to magnesium, zinc, cadmium, have a very definite constitution; they consist of—1st, a single line; 2nd, a pair of lines; 3rd, three to four groups of triplets; 4th, a quadruple group; 5th, a quintuple group of lines. The intervals between the individual lines in the different groupings increases with the increase in the atomic weights of the elements. In fact these spectra present a considerable addition to the body of evidence in support of the view that elements whose atomic weights differ by an approximately constant quantity, and whose chemical properties are similar, are truly homologous bodies, or, in other words, are the same kind of matter in different states of condensation. Their particles are vibrating in the same manner but with different velocities.

In the spectra of the metals calcium, strontium, and barium, successive pairs of lines are a strong feature, in addition to which there are some other groups in the spectrum of barium. The individuals of each pair are separated by smaller intervals, the more refrangible the lines, and by longer intervals the higher the atomic weights. It cannot be said that the spectrum of beryllium is precisely similar in constitution to either of these groups of elements, which it should be if it strictly belonged to one of them. There is some slight resemblance in character to the spectrum typical of the calcium group, beryllium showing two pairs of lines, the individuals of the first or less refrangible pair being separated by a greater interval than those of the second pair. It is a spectrum analogous to that of lithium, having but few lines and no striking resemblance to the elements which follow in the series, because it stands at the head of two sub-groups. Hence it has been concluded that beryllium is the first member of a dyad series to which probably calcium, strontium, and barium are more strictly homologous than magnesium, zinc, and cadmium. It is to be understood that this is a conclusion drawn from one view only, and is open to correction or modification when fresh facts shall have been discovered, but so far the views of Professor Emerson Reynolds and Dr. Brauner are maintained by these spectrum observations, for beryllium is shown to be quite out of place among the triad elements, including those belonging to the rare earths.

* P. 31, June, 1883.
† Watts's "Index of Spectra."
‡ *Proc. Roy. Soc.*, 1880, vol. 31, p. 37.

* *Kongl. Svenska Ahademiens Handlinger*, vol. 12, p. 4; also *Comptes Rendus*, vol. 91, p. 45.

SEPARATIONS OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tantalic Acid.

When galliferous tantalic acid has not been strongly ignited, it may be obtained in a soluble state by fusion with ammonium bisulphate and treatment of the cold mass with water. In the opposite case it is treated with potassium bisulphate at a red heat and taken up in water, which deposits almost all the tantalic acid in an insoluble form; this is then melted with ammonium bisulphate. The author gives the five following methods:—

1. The sulphuric solution is diluted with water and boiled. The precipitate contains the tantalic acid and merely a very small quantity of gallium, which is eliminated by acting upon the tantalic acid again with ammonium bisulphate and re-precipitating by boiling the dilute solution. Two or three such operations generally suffice to eliminate all the gallium. But as the boiled sulphuric liquids are very acid, sensible traces of tantalic acid escape precipitation. After filtration the liquids are therefore partially neutralised, leaving them only moderately acid, and boiled again. The small quantity of tantalic acid, rich in gallium, which is thus collected, is treated separately; the gallium is extracted by successive fusions with ammonium bisulphate, and the slightly acid solutions are boiled.

2. The substance is melted with potassium bisulphate at a red heat, and treated with boiling water, which dissolves the salt of gallium, and leaves the tantalic acid as an insoluble compound. Three operations are necessary to deprive the tantalic precipitate of all gallium, but the filtrates still retain some slight traces of tantalic acid, which are recovered by boiling, after quasi-neutralisation, and treating the precipitate as described in the former paragraph.

3. When the proportion of gallium is slight we may utilise the solubility of this oxide in ammonia. The clear tantalo-gallic solution is poured into a large excess of dilute ammonia, and filtered after repeated stirrings. The precipitate of tantalic acid retains more or less gallium, and it is therefore again fused with ammonium bisulphate, and treated with ammonia. Three or four operations generally suffice to remove the last traces of gallium.

4. The sulphuric solution is mixed with tartaric acid and a salt of manganese, and supersaturated with ammonia. In this mixture ammonium sulphide gives a precipitate which carries down the gallium, and but little tantalic acid. It is washed very well, and the gallium is extracted by known methods. This method is very suitable for determining slight quantities of gallium in presence of much tantalum. The manganese sulphide must be filtered without delay, as in the course of a day tantalic acid is deposited spontaneously, and becomes mixed with the precipitate.

5. The sulphuric solution is mixed with tartaric and arsenious acids, and an excess of acid ammonium acetate, and is then treated with hydrogen sulphide. If the liquid is turbid it may be clarified by a short application of heat before passing in the hydrogen sulphide. Little or no tantalic acid remains in the galliferous arsenic sulphide.

Separation from Niobic Acid.

1. The niobic acid is precipitated by boiling the dilute sulphuric solution, following exactly the process No. 1, given above, for the separation of gallium and tantalum. Although the precipitation of niobic acid is more complete than that of tantalic acid in solutions of the same acidity, the niobic solutions should nevertheless be partially neutralised.

2. The substance is attacked with potassium bisulphate at a red heat; taking the precautions indicated under No. 2 for tantalum.

3. The gallium is carried down with manganese sulphide, taking the precautions indicated under the method No. 4 for tantalum.

4. The method with arsenious acid is carried out exactly as directed for tantalum.

5. Ammonia may serve for separating gallium from niobic acid. Niobic acid is not as absolutely insoluble in ammonia as is the tantalic acid.—*Comptes Rendus.*

RECENT ANALYSES OF THE ASH OF FUCUS VESICULOSUS AND FUCUS SERRATUS.

By A. B. GRIFFITHS, M.A., Ph.D., F.C.S., Medallist in Chemistry and Botany, &c.

The following are recent analyses of the ash of two common kinds of sea-weeds found on our shores:—

Fucus vesiculosus (*Bladder Wrack*).

	I.	II.
Potash	14·91	14·89
Soda	11·54	11·52
Calcium oxide	10·46	10·49
Magnesium oxide	7·29	7·33
Ferric oxide	0·59	0·60
Sodium chloride	25·99	25·97
Silica	1·45	1·44
Sulphuric acid	25·36	25·30
Phosphoric acid	2·37	2·38
	99·96	99·92

Fucus serratus.

	I.	II.
Potash	4·99	5·01
Soda	18·98	18·90
Calcium oxide	14·75	14·79
Magnesium oxide	10·39	10·38
Ferric oxide	0·50	0·52
Sodium chloride	23·96	23·94
Silica	1·50	1·52
Sulphuric acid	20·89	20·90
Phosphoric acid	3·93	3·92
	99·89	99·88

Bromsgrove, Sept. 3, 1883

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending September 30th, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, October 4th, 1883.

Sir,—We submit herewith the results of our analyses of the 210 samples of water collected during the past month, on the several days indicated, from the filtered water reservoirs of the seven London Water Companies taking their supply from the Thames and Lea.

It will be observed that we have on this occasion collected our samples not as usual from the mains, but from the reservoirs of the several Companies before its entry into the mains.

In Table I. we have recorded the analyses in detail of

samples, one taken daily, from September 1st to September 30th inclusive. The purity of the water, in respect of organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted for analysis.

Of the 210 samples of water submitted to examination, the whole, with the exception of five samples which were recorded as "very slightly turbid," were clear, bright, and well filtered.

The water supplied to London during the month of September continues to be of most excellent quality. With comparatively few exceptions, the samples submitted were characterised by a remarkable absence from other than blue colour. In respect to aëration and freedom from organic matter, the waters were unimpeachably excellent.

In Dr. Frankland's report to the Registrar-General, on the quality of the water supplied to the metropolis during the month of August, it is stated that the so-called "organic impurity" of the river derived water was from 2¼ to 2¾ times as great as that of a particular well-water adopted by himself as a standard. As usual, however, it is not pointed out, *per contra*, that the so-called "previous sewage contaminations" of the standard well-water is more than twice as great as that of the Thames and Lea derived waters,—a comparison for the significance of which we would refer to the foot-note appended to our August report. Neither is it pointed out, though shown by Dr. Frankland's own figures, that the so-called "organic impurity" of the river supply of London is appreciably below that of the Corporation of Birmingham's supply, and also of the highly reputed Loch Katrine water supplied by the Corporation of Glasgow. It is not for us to furnish an explanation of these omissions from an official and presumedly impartial report.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

A RECALCULATION
OF
THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

FLUORINE.

THE atomic weight of fluorine has been determined only by one general method, namely, by the conversion of fluorides into sulphates. Excluding the early results of Davy,† we have only to consider the experiments of Berzelius, Louyet, Dumas, and De Luca, with reference to the fluorides of calcium, sodium, potassium, barium and lead.

The ratio between calcium fluoride and sulphate has been determined by the four investigators above named, and by one general process. The fluoride is treated with strong sulphuric acid, the resulting sulphate is ignited, and the product weighed. In order to ensure complete transformation special precautions are necessary; such, for instance, as repeated treatment with sulphuric acid, and so on. For details like these the original papers must be consulted.

The first experiments in chronological order are those of Berzelius,* who operated upon an artificial calcium fluoride. He found, in three experiments, for one part of fluoride the following of sulphate:—

1·749
1·750
1·751

Mean 1·750 ± 0·0004

Louyet's researches† were much more elaborate than the foregoing. He began with a remarkably concordant series of results upon fluor-spar, in which 1 grm. of the fluoride yielded from 1·734 to 1·737 of sulphate. At first he regarded these as accurate, but he soon found that particles of spar had been coated with sulphate, and had therefore escaped action. In the following series this source of error was guarded against.

Starting with fluor-spar, Louyet found of sulphate as follows:—

1·742
1·744
1·745
1·744
1·7435
1·7435

Mean 1·7437 ± 0·0003

A second series, upon artificial fluoride, gave:—

1·743
1·741
1·741

Mean 1·7417 ± 0·0004

Dumas‡ published but one result for calcium fluoride. 0·495 grm. gave 0·864 grm. sulphate, the ratio being 1 : 1·7455.

De Luca‖ worked with a very pure fluor-spar, and published the following results. The ratio between $CaSO_4$ and 1 grm. of CaF_2 is given in the third column:—

0·9305 grm.	CaF_2 gave	1·630 grms.	$CaSO_4$.	1·7518
0·836	,,	1·459	,,	1·7452
0·502	,,	0 8755	,,	1·7440
0·3985	,,	0·6945	,,	1·7428

If we include Dumas' single result with these, we get a mean of 1·7459 ± 0·0011.

Upon combining all these series we get as follows:—

Berzelius..	1·7500	± 0·0004
Louyet 1st series	1·7437	0·0003
,, 2nd ,, ...	1·7417	0·0004
De Luca and Dumas ..	1·7459	0·0011
General mean	1·74493	± 0·0002

For the ratio between the two sodium salts we have experiments by Dumas and by Louyet.§ According to Louyet 1 grm. of NaF gives of Na_2SO_4:—

1·686
1·683
1·635

Mean 1·6847 ± 0·0006

The weighings published by Dumas are as follows:—

0·777 grm.	NaF give	1·312 grms.	Na_2SO_4.	1·689
1·737	,,	2·930	,,	1·687

Mean 1·688 ± 0·0007

The general mean of both series is 1·6863 ± 0·0004

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* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Phil. Trans.*, 1814, 64.

* *Pogg. Annal.*, 8, 1. 1826.
† *Ann. Chim. Phys*, (3), 25, 300. 1849.
‡ *Ann. Chem. Pharm.*, 113, 28. 1860.
‖ *Comptes Rendus*, 51, 299. 1860.
§ See the papers already quoted.

Dumas also gives experiments upon potassium fluoride. The quantity of sulphate formed from 1 grm. of fluoride is given in the last column :—

1·483 grms. KF	give	2·225 grms.	K_2SO_4	1·5002
1·309	,,	1·961	,,	1·4981

Mean 1·4991 ± 0·0007

The ratios for the fluorides of lead and of barium are due entirely to Louyet. 1 grm. BaF_2 gave of $BaSO_4$:—

1·332
1·331
1·330

Mean 1·331 ± 0·0004

With the lead fluoride a new method of treatment was adopted. The salt was fused, powdered, dissolved in nitric acid, and precipitated by dilute sulphuric acid. The evaporation of the fluid and the ignition of the sulphate was then effected without transfer. 5 grms. of fluoride were taken in each operation, yielding of sulphate :—

6·179
6·178
6·178

Mean 6·1783 ± 0·0002

We now have five ratios to calculate from, as follows :—

(1.) CaF_2	$CaSO_4$	:: 1·0 : 1·74493 ±	0·0002
(2.) NaF	Na_2SO_4	:: 1·0 : 1·6863	0·0004
(3.) KF	K_2SO_4	:: 1·0 : 1·4991	0·0007
(4.) BaF_2	$BaSO_4$	:: 1·0 : 1·3310	0·0004
(5.) PbF_2	$PbSO_4$	:: 5·0 : 6·1783	0·0002

From these we get five values for F :—

From (1)	F = 18·929 ±	0·006
From (2)	,, 19·050	0·014
From (3)	,, 18·975	0·032
From (4)	,, 18·993	0·033
From (5)	,, 19·092	0·016
General mean	,, 18·984	0·0065

If O = 16, this becomes 19·027.

Before leaving the subject of fluorine we must notice two possible sources of error beyond the always to be considered one of impurities in the materials employed. First, an incomplete conversion of a fluoride into a sulphate would lead to results tending to raise the atomic weight of fluorine. On the other hand, the value for fluorine which has most weight is that derived from calcium fluoride. But it was shown under calcium that the atomic weight determined for that metal was probably a trifle too high. This error introduced into our fluorine calculations tends to lower our final results. These two errors, then, if they really exist, will, in part at least, compensate each other.

DETECTION OF HYDROCYANIC ACID IN CHEMICO-LEGAL INVESTIGATIONS.

By H. BECKURTS.

HYDROCYANIC acid and the poisonous metallic cyanides are generally demonstrated in toxicological cases by acidifying the substance in question with tartaric acid, distilling, and showing the presence of hydrocyanic acid in the distillate by well-known processes. Otto, however, has proved the inaccuracy of the assumption that a mass containing potassium ferrocyanide or other non-poisonous double cyanides, and slightly acidulated, does not give off hydrogen cyanide. His experiments even prove that neutral solutions of potassium ferrocyanide, if a current of air is passed through them, give off small quantities of hydrogen cyanide, even at common temperatures.

The following methods, which are well known, though generally neglected, are therefore to be employed :—

1. *Jacquemen's Process for detecting Hydrocyanic Acid or Potassium Cyanide in Presence of Non-Poisonous Double Cyanides.*—The mass in question is mixed with a concentrated solution of sodium bicarbonate, and distilled over the naked flame or in an oil-bath. To prevent spirting, the neck of the retort is turned slightly upwards, and connected with the refrigerator by means of an elbowed tube. The distillate is then examined for hydrogen cyanide in the ordinary manner. If the well-known reactions occur it is certain to have been present in the free state, or in the form of potassium cyanide, or similar poisonous cyanides. This method is extremely sensitive, and surpasses all others in accuracy and simplicity. It is not available for mercury cyanide, which is not decomposed by carbonic acid, even in a neutral solution.

2. *Barfoed's Process for detecting Hydrocyanic Acid and Poisonous Cyanides in Presence of Potassium Ferrocyanids.*—This method depends on the fact that ether withdraws hydrocyanic acid, but not hydroferrocyanic acid, from a watery solution. The mass in question is acidulated with sulphuric acid or tartaric acid, and shaken up with an equal volume of ether. The ether is drawn off with a pipette, and the operation is repeated with a fresh quantity of ether. The united ethereal extracts, which contain both the free hydrocyanic, and that liberated from the poisonous cyanides, but not hydroferrocyanic acid, is then shaken up with dilute soda-lye, and this solution is tested for hydrogen cyanide in the usual manner. This method is applicable in presence of mercury cyanide.—*Chemiker Zeitung* and *Archiv. der Pharmacie.*

ON THE CONDUCT OF MOIST PHOSPHORUS AND AIR TOWARDS CARBON MONOXIDE.

By IRA REMSEN and E. H. KEISER.

RECENT experiments have drawn attention anew to the question concerning the existence of an active form of oxygen distinct from ozone, and capable of effecting changes which ozone cannot effect. Hoppe-Seyler* and Baumann† hold that the oxidising action of palladium-hydrogen is due in the first instance to the splitting up of the molecule of ordinary oxygen by the active hydrogen, resulting in a momentary liberation of atoms of oxygen which exhibit very active properties. Traube,‡ on the other hand, holds that this action is due to the formation of hydrogen dioxide, and that the oxidising effects noticed are only those of the dioxide. At first, however, this explanation did not appear probable, for Baumann had shown that palladium-hydrogen in the presence of oxygen has the power of oxidising carbon monoxide, and one of us|| had previously shown that hydrogen dioxide has not this power. Traube afterwards conceded this point, but then showed that, while hydrogen dioxide itself has not the power of oxidising carbon monoxide, it has this power in the presence of palladium. We have repeated the experiment of Traube, and can confirm his statement.§ From the evidence thus far submitted, Traube's explanation of

* Hoppe-Seyler, *Zeitschrift für Physiologische Chemie*, 1, 396; 2 22, 25.
† Baumann, *Ibid.*, 5, 244.
‡ Traube, *Berichte der deutschen chemischen Gesellschaft*, 15, 659; 2421; 2434; 2854.
|| Remsen, *Amer. Chem. Journ.*, 4, 50.
§ We notice that if a small quantity of free hydrochloric or sulphuric acid is present in the hydrogen dioxide, some of the palladium is dissolved. Similar observations have been made by Fairly (*Berichte der deutschen chemischen Gesellschaft*, 8, 1600; 9, 948), though the statements which we have seen concerning this phenomenon are very meagre.

the oxidising action of palladium-hydrogen certainly appears to be more probable than that of Hoppe-Seyler.

There is, however, one experiment recorded which indirectly lends some some support to Hoppe-Seyler's explanation. We refer to the experiment first performed by Leeds,* and subsequently by Baumann,† which consisted in bringing air and carbon monoxide together in the presence of moist phosphorus. Under these circumstances, according to both authors, oxidation of the monoxide is effected. Accepting the conclusion, the simplest interpretation of the fact is this: The phosphorus acts upon the oxygen, splitting the molecules, uniting with some of the free atoms and momentarily setting others free. The free atoms then unite with oxygen molecules to form ozone, and with carbon monoxide to form the dioxide. This view is similar to that first put forth by Hoppe-Seyler to account for the oxidising action of palladium-hydrogen as above related. If, then, the result reached by Leeds and by Baumann is correct, we have some evidence, though it is not conclusive, of the existence under some conditions of a form of oxygen more active than ozone. We say it is not conclusive, for, as hydrogen dioxide is formed under these circumstances, we may assume that the action is due to combined influence of the dioxide and phosphorus.

The importance of the subject has led us to repeat the experiments of Leeds and of Baumann, and we have been led to a conclusion directly opposed to that recorded by these authors. As they apparently worked with great care and both agree, it will be necessary for us to describe our work in detail in order that any who may wish to convince themselves may avoid sources of error which have been overlooked in the earlier experiments.

We tried first the effect of passing air alone, freed from carbon dioxide, over moist phosphorus. After its exit from the vessel containing the phosphorus it was filtered through a layer of previously ignited asbestos contained in a tube between two and three feet long, and then into a vessel containing clear baryta water. A precipitate was formed at once, and increased in quantity the longer the current continued. It was tested for phosphoric acid and for phosphorus compounds in general, but not a trace of these could be detected. The passage of air through the apparatus was continued for some days for the purpose of collecting enough of the precipitate for examination and analysis. It proved to be nothing but barium carbonate.

The carbon dioxide must have come from one of two sources, either from some carbonaceous material contained in our phosphorus, or as the result of the action of ozone on the cork stoppers used to make connections. The exposure of rubber had been avoided almost entirely, but still there was some slight opportunity for contact of the ozone with the rubber in consequence of diffusion. As, however, we had here taken the same precautions as in the earlier experiments on carbon monoxide and ozone; as, further, Baumann‡ appears to have experienced no difficulty from the use of rubber joints, it seemed not improbable that the trouble in our experiment was in the chemical condition of the phosphorus. We hence procured specimens of phosphorus from as many different sources as possible, and with each of these repeated the above described experiment, using the same form of apparatus. In every case the precipitate of barium carbonate was obtained, and, as far as could be estimated, in about the same quantity. Attempts were then made to purifiy the phosphorus. One specimen was placed in hot water under the receiver of an air-pump, and the air exhausted for the purpose of getting rid of any gases which might be contained in the phosphorus. Other specimens were distilled in an atmosphere of pure hydrogen and the vapour condensed in cold water.‖ No matter what process of purification was adopted, the phosphorus acted in the same way after the purification as before.

Attention was now directed specially to the corks and rubber connections. An apparatus was finally constructed in which these were entirely excluded, or, at least, so protected that the ozone could not possibly reach them. Although a number of different forms of apparatus were tried, we need only describe that which we finally decided upon as the best. This consisted of a flask of from three to four litres capacity, provided with a doubly perforated cork stopper. Through this there passed one glass tube reaching to the bottom of the flask, and another reaching only half way. Outside the flask the shorter tube was connected with the apparatus intended to remove the carbon dioxide from the air, and the longer tube was bent twice at right angles, and then passed through the stopper of a U-tube about eight inches high. Between this U-tube and a second like it, connection was made by means of a doubly bent glass tube. In the flask there were placed usually two or three sticks of phosphorus each three or four inches long, and enough pure water to somewhat more than fill the neck when the flask was inverted. The U-tubes were filled with ignited asbestos, and there was then added some mercury so that when the tubes were inverted, in which position the entire apparatus was placed when in use, the metal covered the corks with a layer from three-quarters of an inch to an inch in thickness. The connecting tubes passed, of course, in each case through the layer of mercury. The vessel containing the clear baryta water was also connected with the last U-tube by means of a mercury joint similar to those above described. The baryta water was protected from the action of the air by placing before it a small U-tube containing potassium hydroxide, and this last tube was connected with an aspirator. Before connecting the bulbs containing the baryta water, air freed from carbon dioxide was drawn slowly* through the apparatus. On now connecting with the baryta-water bulbs no precipitate was formed. Even on allowing the air to remain in contact with the moist phosphorus for periods varying from one to twelve hours, no carbon dioxide could be detected. This experiment was tried over and over again at different temperatures, but always with the same result.

About one-third of the air in the ozone flask was now replaced by carbon monoxide from which all dioxide had been scrupulously removed. The mixture was allowed to stand for some hours and then drawn through the baryta-water bulbs, when no precipitate was formed. This experiment was repeated a number of times with the same result. In some cases the air and carbon monoxide were drawn together slowly for a long time over the moist phosphorus, but this made no difference in the result. So frequently was the experiment performed, so great were the precautions against error, and so undeniably negative were the results, that, in spite of the explicit statements of Leeds and of Baumann, we do not hesitate to say that carbon monoxide is not oxidised when exposed to the action of air and moist phosphorus. It follows, of course, from this that the action of air and moist phosphorus on carbon monoxide furnishes no evidence in favour of the view that there is an active condition of oxygen distinct from ozone.

Leed's error is easily explained. In the first place he took no special precautions to protect the corks from the action of the ozone, and in the second place he passed the gases through a filter of moist cotton for the purpose of removing "oxides of phosphorus." Now cotton, as it is usually met with, yields carbon dioxide when subjected to the influence of ozone, so that the carbon dioxide noticed by Leeds was probably the result of the action of ozone on the cotton or the oily substances which always adhere to it. To test the probability of this explanation, we introduced a short plug of cotton into one of the tubes of our

* *Journ Amer. Soc.*, 1, 232.
† *Zeitschrift fur physiologische Chemie*, 5, 250.
‡ *Loc. cit.*
‖ In this way a new modification of phosphorus, "white phosphorus," was discovered. See next paper.

* This operation requires care and constant attention. The phosphorus not unfrequently takes fire. In one case in our experience it took fire after having stood quietly and unmolested for several hours.

apparatus. It having been shown previously that the air drawn through this apparatus contained no carbon dioxide, it was now found that the presence of the cotton alone soon caused the appearance of a precipitate in the baryta water. This experiment, was frequently repeated.

Baumann describes his experiments thus :*—"Ein langsamer Strom von kohlensäurefreier Luft wurde durch eine Flasche in welcher sich feuchter Phosphor befindet, und von da in eine zweite Flasche übergeleitet, in welcher die ozonosirte Luft einem etwas langsameren Strom eines kohlensäurefreien Gemenges von 3 Volum Sauerstoff und 1 Volum Kohlenoxyd begegnet; aus dieser Flasche treten die Gase durch klares Barytwasser. Das Barytwasser blieb, nachdem aus dem Apparate selbst erst alle Kohlensäure entfernt war, bei 6-stündigem Durchleiten der Gase völlig klar. Wurde dagegen die Mischung von Kohlenoxyd und Sauerstoff in die Flaschen eingeleitet, in welcher der Phosphor sich befand, und nach unserer Vorstellung aktiver Sauerstoff auftreten muss, so ist das Resultat ein ganz anderes: das vorgelegte Barytwasser wird schon nach kurzer Zeit trübe und im Laufe einer Stunde bildet sich ein reichlicher Nieperschlag von kohlensaurem Baryt."

Nothing is said about stoppers or rubber connections, and it is safe to assume that, in the apparatus used by Baumann, ozone came in contact at some points with organic matter. Hence the formation of carbon dioxide is easily accounted for. But to account for the negative result when no carbon monoxide was used is not so easy. It can only be said that, if the ozone formed is not concentrated, the action on organic connections is not marked. Now, if the temperature should happen to be a few degrees lower than the ordinary temperature of rooms, the formation of ozone would be retarded and there might not be formed enough to act perceptibly on the stoppers, &c. The rate of the current of gas is also of importance. The more rapid the current of air passed over the phosphorus the less ozone it contains, and indeed unless the current be quite slow the oxidising effect of the ozone on the organic connections does not reveal itself by the formation of a precipitate in the baryta water. Whatever the sources of error in Baumann's experiment may have been, we are confident that a repetition with the precautions taken by us will show him that his conclusion is wrong.—*American Chemical Journal.*

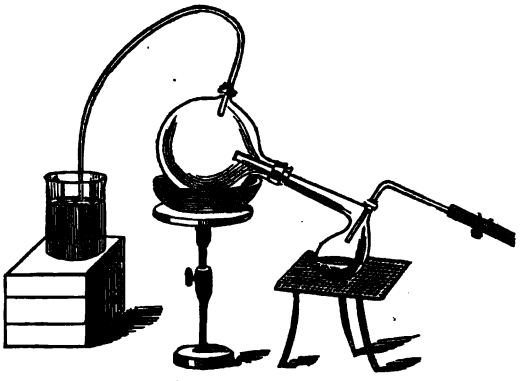
WHITE PHOSPHORUS.

By IRA REMSEN and E. H. KEISER.

In the course of the experiments described in the preceding paper, the suspicion arose that the phosphorus with which we were working might contain some carbonaceous impurity. With the view of removing this if possible, we distilled some of the phosphorus in an atmosphere of purified hydrogen and condensed the vapour on cold water. We were much astonished to find that the substance thus obtained differed very markedly in appearance from ordinary phosphorus, and indeed we thought at first that it could not be the element, but must probably be some new oxide, formed in consequence of a slight leak in the distilling apparatus. It floated on the surface of the water in the receiver, forming a snow-white layer about a quarter of an inch in thickness. On examining it more carefully it was found that it was insoluble in water, and could be changed to ordinary phosphorus very easily. The entire quantity obtained in the first experiment happened to be brought into some warm water and was changed at once into ordinary phosphorus. We now endeavoured to prepare the substance again, but found considerable difficulty in meeting the right conditions. While we always obtained some of it, we were obliged to make a large number of experiments before the conditions of success became clear. The experiment should be performed as described in detail below.

An apparatus like that roughly illustrated in the accompanying figure should be used.

It is essential that the neck of the retort be inclined upward and that it project well within the receiver. In the receiver there is a layer of ice-cold water from one to one and a half inches deep in the deepest part. In this, lumps of ice are brought, enough to form a fairly compact mass of ice. The receiver rests in a vessel containing cold water. The beaker into which the bent tube dips also contains cold water. Two or three sticks of ordinary phosphorus having been brought into the retort, connection is made by means of the rubber tube with a hydrogen-generating apparatus. The hydrogen is passed first through a solution of potassium permanganate and then through the apparatus as above sketched. As soon as the apparatus is completely filled with the gas the current of hydrogen is stopped by means of the pinch-cock. The distillation is now begun. As soon as the phosphorus vapour reaches the end of the neck of the retort it falls down on the ice and water and forms a white coating. Under some circumstances the material is deposited in piles reaching the height of a half an inch to an inch. The principal precaution necessary is to prevent the boiling from becoming so active that the vapour condenses to form liquid just after it leaves the retort neck. In successful operations there will be found at the end a cake of white



material floating on the surface of the water, varying in thickness according to the amount of phosphorus distilled. Usually this is quite thin. In order to remove it, it is best to allow the whole apparatus to cool down to the temperature of the air, then to disconnect the retort from the receiver, and put the receiver, with its contents, under water in a larger vessel. In this way the hydrogen can be displaced without danger, and afterwards the white phosphorus can be easily removed. If the above precaution is not taken the receiver becomes filled with a mixture of hydrogen and oxygen while the phosphorus is being taken out, and a little friction may set fire to the phosphorus, thus giving rise to an extremely unpleasant explosion. This actually happened in one of our experiments, and one of us (Keiser) still carries the marks of the explosion.

White phosphorus is light and plastic. If placed on a piece of bibulous paper so that the water is absorbed from it, it gives off dense white fumes, melts but does not take fire, and is then nothing but ordinary phosphorus. It dissolves readily in carbon bisulphide. It melts at exactly the same point as ordinary phosphorus, and at this point is completely transformed into the latter. From these it seems clear that this curious substance bears to ordinary phosphorus much the same relation as "flowers of sulphur" to "roll brimstone." It is in a different physical condition. It is much less susceptible to the influence of sunlight than ordinary phosphorus. We have in our possession some specimens made last October which have

* *Zeitschrift für physiologische Chemie*, 5, 250

undergone very little change, though they have not been specially protected from the action of the light. One specimen, which was purposely placed where the direct sunlight would be upon it for some time every day, has become slightly yellow, but is otherwise, as far as we can judge, quite unchanged. It is still plastic, and when dried acts as above described.

We have not been able to find any references in chemical literature to a substance like that which we have described. The white phosphorus referred to in the communications of Pelouze,* H. Rose,† Caignard-Latour,‡ Mulder,‖ Marchand,§ and Baudrimont,¶ is the coating found on sticks of ordinary phosphorus which have been preserved under water. Böttger** also speaks of a variety of white phosphorus prepared by dissolving ordinary yellow phosphorus in alcoholic potassium hydroxide, pouring off the liquid after the phosphorus has become perfectly clear, and then adding ice-water. The phosphorus solidifies as a snow-white brittle mass, which can be pulverised under water. From Böttger's description of his product it is evident that it must be quite different from our white phosphorus.—*American Chemical Journal.*

CORRESPONDENCE.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.

To the Editor of the Chemical News.

Sir,—Having been unable to attend the meeting of Section B of the British Association last month, I have been very thankful for the opportunity afforded me of reading Mr. Brereton Baker's paper in the Chemical News, vol. xlviii., page 187.

With your permission I will make a few observations in defence of the accuracy of my work on the synthesis of ammonia.

Both Mr. Baker and myself would have been saved much trouble if my paper, which was read before the Royal Society in 1881, and to which he alludes, had been honoured by publication. I presume that Mr. Baker has not read that paper, though I believe it may be read, being "in the Archives" of the Royal Society, though unpublished; for, had he done so, he would have found his objections to my work completely answered therein.

Mr. Baker rejects my hypothesis of the existence of an active form of nitrogen upon the ground that the ammonia obtained in my experiments may have been due to the presence of oxides of nitrogen derived from the reducing action of hydrogen upon solution of nitrate of silver employed to purify that gas. This source of error was pointed out to me in March, 1881, and since then I have avoided the use of nitrate of silver as a purifying agent for hydrogen altogether. Accordingly, in my paper read before the Royal Society in November, 1881, I describe my hydrogen as purified by "solution of chromic and sulphuric acids."

But the most conclusive proof that the formation of ammonia in my experiments was perfectly independent of any impurity in the hydrogen gas which I employed is contained in the following paragraph, which I quote from my paper above mentioned.

"It is always easy to ascertain whether the ammonia formed in spongy platinum is produced by the action of nitric oxide or of active nitrogen. It is only necessary or this purpose to heat the nitrogen in a glass tube to dull redness before mingling it with hydrogen, and allowing it to enter the spongy platinum. If the nitrogen contain nitric oxide, that gas remains unaltered by the heat, passes on, and yields ammonia in the platinum; whereas, if the nitrogen be pure, any active gas it may have contained will be destroyed by the heat" (*i.e.*, rendered inactive) "and no ammonia will be formed by synthesis, as long as the tube through which it passes remains hot."

Now this somewhat dogmatic statement was the result of numerous and careful experiments; and it is at once obvious that since nothing was done to alter the *hydrogen*, the *nitrogen* alone being heated, *before its admixture with hydrogen*, the cessation of the formation of ammonia must have been due to a modification of some constituent of the nitrogen effected by the heat; and the non-production of ammonia, so long as the nitrogen was being heated, proves that *the hydrogen contained no gas capable of yielding ammonia in heated spongy platinum.*

In some recent experiments, the results of which I hope to publish *in extenso* before the close of this year, I have considerably enlarged my knowledge of the products of the decomposition of solutions of ammonium nitrite by heat. The hydrogen in these experiments was purified by solution of mercuric chloride, followed by one of caustic potash, but the results obtained have only tended to confirm my active-nitrogen hypothesis, and to convince me that nitric oxide has nothing to do with the phenomena observed.

Perhaps, Sir, as I am alluding to my paper read before the Royal Society in 1881, you will allow me to ask if any of your readers can inform me whether any chemist had observed the complete synthesis of ammonia from a mixture of nitrogen and hydrogen gases previous to that date.

I described in that paper how a mixture of pure nitrogen and hydrogen confined over strong sulphuric acid, or over mercury in presence of charcoal, if mixed in the proportions to yield ammonia, are completely, though slowly, converted into that gas by a continued series of electric sparks, the ammonia being converted into ammonic sulphate in the first instance, and being absorbed by the charcoal in the second.

I have been told by more than one chemist that this is not my discovery; but, I ask, to whom is it due? At the Royal Society I was told that M. Henri Ste.-Claire Deville had forestalled me in this matter. But, though I have carefully studied his paper on the subject (which is very brief, *vide Comptes Rendus*, 1865, lx., pp. 324 and 325), I can only find in it a demonstration that the dissociation of ammonia by the electric spark is never perfect, and a description of the *synthesis of sal-ammoniac* by the continued action of the sp rk upon $N+H_3+HCl$. My synthesis was conducted in the absence of any third gas, even in the absence of the *vapour of water.*

Mr. Donkin's partial synthesis of ammonia was effected by means of the *effluve* in an induction-tube. His results are confirmed and commented on in my unpublished paper before alluded to.—I am, &c.

G. Stillingfleet Johnson.

King's College, London,
October 22, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 13, September 24, 1883.

Peptone of Gelatin.—M. Tatarinoff.—Gelatin, during its conversion into peptone, is not profoundly modified. It merely takes up the elements of water, as is done under similar circumstances by the albumenoids.

* *Annales de Chimie et de Physique*, 50, 83.
† *Poggendorff's Annaln*, 27, 563.
‡ *L'Institut*, 1834, No. 34.
‖ *Journ. Pharmacie*, 23, 20.
§ *Journ. für Praktische Chemie* 20, 506.
¶ *Comptes Rendus*, 61 ,857.
** *Journ. für Chemie und Physik*, 67, 141, *and* 68, 141.

Note on the Solar Spectra. Refraction Apparatus of Rock Salt.—P. Dessain.—The author gives his results in the form of tables.

Induction due to the Variation of Intensity of the Electric Current in a Plane Circuit and in a Cylindrical Solenoid: Two Laws Analogous to those of Biot and Savart.—M. Quet.—A purely mathematical paper.

Distribution of Potential in Liquid Masses of Determinate Form.—A. Chervet.—A mathematical memoir, not admitting of useful abstraction.

No. 14, October 1, 1883.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 197.

Presence of Arsenic in Certain Wines in the Absence of Foreign Colouring-Matter.—A. Barthélemy.—The author has traced arsenic in such cases to the use of common sulphuric acid, made from pyrites, in purifying casks which had acquired a bad flavour.

Determination of Chloroform in the Blood of an Anæsthetised Animal.—MM. Gréhaut and Quinquand.—The authors distil the blood in a vacuum, and determine the chloroform by its indirect reducing action upon cupro-potassic liquid at 100°.

Bulletin de la Société Chimique de Paris.
Nos. 4 and 5, September 5, 1883.

Two Isomeric Benzyl-naphthalines.—MM. Camille Vincent and Leon Roux have obtained these two isomeric hydrocarbons by the general method with aluminium chloride devised by MM. Friedel and Crafts. The α-benzyl-naphthaline takes the form of brilliant, colourless orthorhombic laminæ. It dissolves in 60 parts of ordinary alcohol at 15°; it melts at 59°; its spec. grav. at 0° is 1·165. The β-compound forms klinorhombic prisms, which dissolves in 44 parts of alcohol at 15° and melt at 55°—55·5°. The sp. gr. at 0° is 1·176.

"Disinfection" of Alcohols of Bad Flavour by Electrolysis.—M. Laurent Naudin. A somewhat warm reply to a criticism in the *Chemiker Zeitung*.

New Copper Oxide Battery.—MM. F. de Lalande and G. Chaperon.—This paper requires the three accompanying illustrations.

Formation-Heat of the Alcoholates.—M. de Forcrand.—The author gives his results in the form of a table.

Russian Chemical Society (*Meeting of February*, 3/15, 1883).—M. Menschoutkine communicated his researches on the reciprocal displacement of the bases in the solutions of their neutral salts.

M. Kanounikoff sent in a note on the specific refractive energy of organic substances in solution.

M. Dieff contributed researches on an accessory product, distilling about 165° and 185°, obtained in the preparation of allyl-dimethyl-carbinol.

MM. Nikolsky and Saytzeff have conducted researches on the hydrocarbon $C_{12}H_{20}$ obtained on setting out from allyl-dimethl-carbihol.

M. Reformatsky has investigated the hydrocarbide obtained by the action of sulphuric acid upon allyl-dipropyl-carbinol.

M. Chechoutkoff, on causing chlorine to act upon an excess of isobutylene, observes an escape of hydrochloric acid and the formation of isocrotyl chloride.

M. Kurbatoff, on causing chlorine to act upon the fraction 135°—140° of the Caucasian petroleum, has obtained a crystalline compound, $C_6H_5Cl_3$, melting at 208°.

M. Kirpitchnikoff described an apparatus for obtaining a uniform flow of any liquid whatever, and a new process for extracting sulphur from its ores.

Dr. Stefanowicz has analysed the waters found in the holds of Russian ships.

M. Alekine has examined di-isooctyl prepared by the action of sodium upon a solution of capryl bromide in xylene.

M. Sokoloff described modifications introduced into his apparatus for gas analysis.

M. Potilitzine sent in analyses of water from a mud volcano in the Government of Tiflis, containing organic substances, probably acids of the fatty series.

M. W. Pavloff described a new process for the formation of the tetric acid of Demarcay.

Meeting, March 3/15.—M. Przybter described the formation of a potassium salt of glycolic acid, and the reduction of this acid to acetic acid by hydrocyanic acid.

M. Alexeef communicated the sequel of his researches on solutions.

M. Zaboudsky treated on the determination of carbon in cast-iron and steel.

M. Willm read a paper on the magnetic properties of the ores of platinum.

M. Prohoroff presented a new eudiometric apparatus for determining the oxygen of the air when in proportions between 19·5 and 20 per cent. Precise results may be obtained with this apparatus, without the use of optical instruments, the experimental error not exceeding +0·02 per cent.

M. Mendelejeff explained his researches on the petroleum of Baku. It contains saturated hydrocarbons, C_5H_{12} and C_6H_{14}, identical with the petroleum hydrocarbons of America. He has employed a new method of fractionated distillation, which is not described.

Meeting, April 7/19.—The Commission for examining the lamps for burning heavy petroleum oils, sent in in competition for the Ragosine prize, awarded the palm to the lamp of M. Kumberg.

M. Mendelejeff mentioned that the purified mixture of all the fractions of petroleum burns very well in the above-mentioned lamp, leaving no residue.

M. Poutokine sent in a paper on the allyl-dimethyl-carbinol already studied by M. Dieff.

M. Lwoff expounded his ideas on the structure of the alcohol obtained by Dieff.

M. Rassinky has undertaken researches on the fractions of petroleum distilling above 135°.

M. de Lermontoff and MM. Jakowkine, Konowaloff, and Staroboudsky are studying the fractions boiling between 115° and 150°.

M. Markownikoff presented a note on the formation of tertiary alcohols by the process of M. Butleroff.

M. Radoulowicz has effected an improvement in gas analysis.

M. Beketoff has carried on researches on the formation and properties of sodium protoxide.

M. Mestchersky has studied the decomposition of orthose under the influence of heat.

MM. Tikomiroff and Lidoff have studied the reducing action of the voltaic arc, and the transformation of iron borate into iron boride.

M. Wladowsky has discovered the presence of anthracene among the crystals deposited from the heavy oils of petroleum tar.

According to MM. Gorboff and Kessler, there are formed in the action of sodium isobutylate upon iodoform, methylene iodide and dimethacrylic acid, besides saturated fatty acids.

M. Pavloff gave a communication upon tetric acid.

M. Konowaloff described his recent investigations on the formation of pyrosulphuryl chloride, which when pure boils at 153°. He also read a paper on the solubility of secondary butylic alcohol in water.

M. Alexejeff made a communication on the specific heats of solutions and mixtures of liquids.

In the 4th Part of Vol. xv., of the *Journal of the Russian Chemical Society*, M. Alexejeff states that up to 100° the solubility of aniline in water varies very little. Above 150° it increases very quickly, and at 164·5° it mixes with water in all proportions.

M. Potilitzine gave a paper on the waters accompanying petroleum, and which are ejected by the mud volcanoes.

M. Fistchenko announces that the products of hydrochloric, hydrobromic, and hydriodic acid upon oxymethylene are formic acid and methyl chloride, bromide, and iodide.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 3.

Potassium Sesqui-carbonate.—C. Rammelsberg.—The author shows that this disputed salt exists in a solid, crystalline form, though the conditions under which it is produced have not been determined.

Condensation-product of Phenanthren-quinone and Acetacetic Ether.—F. J. Japp and F. W. Streatfeild.—The compound obtained, $C_{20}H_{16}O_4$, receives the name phenanthroxylen-acetacetic ether. The authors further examine the behaviour of this body with hydriodic acid, which leads to the formation of β-phenanthroxylenicrotonic ether, and the reactions of this last compound with caustic alkalies.

Acetone-addition under the Influence of Caustic Alkalies.—F. R. Japp.—The author mentions that he has been for some time engaged in the study of reactions in which di-ketones, under the influence of ammonia or potassa, take up 1 or 2 mols. acetone. The first compound of the kind obtained has been provisionally named phenanthren-quinimid-acetone.

Condensations of Compounds which contain the Dicarbonyl Group with Aldehyds and Ammonia.—F. R. Japp.—A discussion concerning the constitution of para-oxal-methyline.

Œnanthol-aniline, Œnanthol-xylidine, and Œnanthol-naphthylamine.—A. R. Leeds.—The author has obtained and analysed these compounds, and remarks that all as obtained synthetically by the direct combination of a molecule of œnanthol with a molecule of the organic base without the separation of water, have a relatively high combination-heat.

Chryptidine.—A. R. Leeds.—The author has succeeded in producing cryptidine synthetically.

Insoluble Residue obtained on Distilling Castor Oil in a Vacuum.—A. R. Leeds.—An examination of a tough elastic mass obtained in preparing œnanthol from castor oil. This compound has the composition $C_{42}H_{68}O_5$, and is capable of saponification on prolonged treatment with potassa.

Acroleinureide, with Remarks on H. Schiff's Communications on Condensed Ureides.—A. R. Leeds.—A controversial paper. The author considers that all the researches of Schiff on the ureides require repetition and confirmation.

Addition of Bromine to Acetacetic Ether.—C. Duisberg.—A reply to the papers of Lippmann (*Berichte*, xv., p. 2142) and of Conrad (*Berichte*, xv., 2133).

Action of Phthalic Anhydride upon Quinoline.—C. Traub.—A preliminary communication. The author obtains by this reaction, not quinoline phthaleine, but a compound which he names quino-phthalon, insoluble in water, freely soluble in hot benzol and glacial acetic acid, fusible at 235°, and capable of sublimation, though with partial decomposition.

Ortho-beta-oxy-naphthoyl-benzoic Acid.—H. Walder.—An account of this acid, of its sodium, barium, and silver salts, its methyl and ethyl ether, its acetyl compound, and its behaviour with melting potassa.

Mutual Displacement of Bases in the Solutions of their Neutral Salts.—N. Menschutkin.—This memoir will be inserted at length.

Formation of Arsenides by Pressure.—W. Spring.—A study in detail of the reactions which ensue on submitting pulverised bodies to strong pressures. He has experimented with arsenic and zinc, arsenic and lead, arsenic and tin, arsenic and cadmium, arsenic and copper, and arsenic and silver.

Noack's Memoir on a New Method of obtaining Carbon Monoxide.—H. Jahn.—The writer shows that Noack has been anticipated by Prof. E. Ludwig and by himself (*Kais. Akad. d. Wissenschaft.*, April, 1880).

Compounds of Hydrocyanic Acid with Hydrochloric and Hydrobromic Acids.—L. Claisen and F. Matthews.—The authors have obtained and examined hydrocyano-sesqui-hydrochlorate, $2CNH+3HCl$, and the corresponding bromine compound, both of which are white crystalline solids, insoluble in alcohol, but soluble in water with decomposition.

Glutamine.—E. Schultze and E. Bosshard.—Glutamine, on heating with baryta water or alkalies, takes up water, and is resolved into ammonia and glutamic acid. It undergoes the same transformation if boiled with acids, and is therefore analogous in its behaviour to asparagine.

Action of Chlorine upon Sulphone Compounds and Organic Oxy-sulphides.—W. Spring and C. Winssinger.—Not adapted for abstraction.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Recovery of Sulphur from Spent Oxide.—(Reply to A. S.)—Apply to Schofield, White, & Co., 4, New London Street, Mark Lane, E.C., large buyers of spent oxide. The sulphur is readily dissolved by bisulphide of carbon, which can be recovered by evaporation in a closed retort, &c. It might be better to apply heat and obtain sulphur by sublimation direct without the solvent. If you fail to obtain desired information repeat the question.—G. A. K.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 1.—Chemical, 8. "On the Production of Hydroxylamine from Nitric Acid," by Dr. Divers. "On some Compounds of Phenols with Amido-Bases," by Gibson Dyson. "Chemistry of Lacquer (Urushi)," by H. Yoshida.

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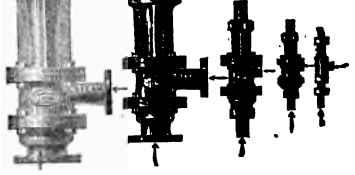

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1249.

CONSTANT PRODUCTION OF OXYGEN GAS BY MEANS OF *PROTOCOCCUS PLUVIALIS* AND THE ACTION OF THE SUN'S RAYS.

By Dr. T. L. PHIPSON, F.C.S., &c.

From March to August of the present year I have devoted much time to what is termed the *respiration of plants*, and have made a considerable number of experiments with phanerogams and cryptogams. The results of these researches will be given later, for they are not yet completed. In the meantime I wish to make known a very efficient manner of obtaining oxygen gas in considerable quantities by means of the microscopic plants *Protococcus pluvialis* and *P. palustris*—two closely allied unicellular algæ, which abound in little pools of rain-water and in pump-water exposed to the air.

In almost all text-books it is stated that plants have the *power of decomposing carbonic acid* and liberating its oxygen, whilst the carbon is "fixed in the vegetable tissue." This statement is quite incorrect: plants have no power of decomposing carbonic acid into oxygen and carbon, nor into oxygen and carbonic oxide. Even in the laboratory the decomposition of carbonic acid is an arduous undertaking requiring violent methods, such as that which I showed formerly in my paper on magnesium by the action of that metal on carbonate of soda at a great heat. Plants absorb carbonic acid from water or air when it is present in the proper proportions (in large quantities it appears to poison them), and oxygen is evolved from their tissues as a consequence of this absorption; but *the carbonic acid is not decomposed.* Water or peroxide of hydrogen is as essential as carbonic acid to the production of oxygen, and the phenomenon which occurs may be briefly stated thus: there are two modes (*a*) and (*b*):—

(*a*) $CO_2+HO=CHO+O_2$—Inferior plants.
(*b*) $CO_2+HO=CHO_2+O$—Higher plants.

The form (*a*) indicates the formation of *sugar*, *starch*, *cellulose*, *gum*, &c.; the form (*b*) that of *acids*, *glucosides*, &c.

The reaction (*a*) *predominates* in inferior plants *without excluding* (*b*); that is why they give more oxygen, in general, than higher plants, added to which they live indefinitely in water, in the condition to be referred to, which is difficult to obtain even with aquatic plants of a higher nature.

On a fine summer morning, when the sun has been above the horizon for 4 or 5 hours, we see the *Zygnema* and *Conferva* borne up to the surface of pools of stagnant water by thousands of minute gas-bubbles. When this gas is collected and analysed it is found to be very pure oxygen. The *Protococcus pluvialis* and *P. palustris*, which are among the simplest of unicellular algæ, I have found to be very remarkable in this respect.

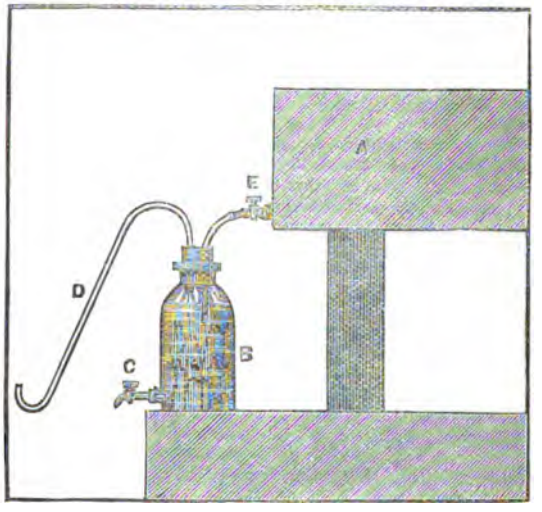
Expose a saucer to the rain for a few months, or leave it, full of pump-water, exposed to air and light for some weeks, and it soon contains *Protococcus pluvialis* in abundance. Place some small dead branches of poplar in the saucer, and both *P. pluvialis* and *P. palustris* develop rapidly upon them in the course of a week or two.

These small branches can then be placed in a flask full of pump water and the evolution of oxygen observed under the influence of the solar rays.

When higher plants, such as *Achillea millefolium*, are experimented on in this way, the gas accumulates at the extremities of the leaves, sometimes in bubbles of considerable size, which finally escape and come to the surface in quantities varying from the size of a pin's head to that of a pea or a bean. But with the *Protococcus pluvialis* and *P. palustris* the escape of gas is constant, and each bubble is of the minutest size. No sooner do the sun's rays strike the flask than a series of these microscopic bubbles—veritable atoms of oxygen—commence rising in all directions, and from their great number create quite a froth upon the surface. The flask being turned upside down for the purpose of collecting and ascertaining the composition of the gas, this state of things will continue for about three days; after that time all the carbonic acid contained in the water is absorbed, and the escape of oxygen gas ceases. (A minute quantity of caustic soda will cause it to cease on the first day, by depriving the plant of carbonic acid.)

When the water is renewed the same phenomenon recommences, so that by keeping up a constant supply of pump-water the production of oxygen may be kept up for months, and probably years together.

This is effected by means of the simple apparatus now to be described:—



The water used is pump-water (water that has been boiled or distilled will not answer, nor will the phenomenon occur if the slightest quantity of alkali of any kind be present in the water). The tank A is of *slate* or *earthenware*; it is full of pump-water on which the sun's rays cannot act on account of the opacity of the sides; it is kept filled and covered. B is a large wide-mouthed and tubulated glass flask, in which are placed the dead branches of poplar covered with *Protococcus pluvialis* and *P. palustris*. (These microscopic plants are almost invisible, save that here and there on the dark epidermis of the branches little patches of green matter are observable.) The flask B is exposed to the direct rays of the sun. The flow of water from the tank A is regulated by the tap E, and that from the flask by the tap C, *so that the contents of the latter are completely renewed in the course of three days*; or the water in B may be completely drawn off every third or fourth day.

In these conditions any quantity of oxygen may be produced in a short space of time: *the quantity yielded in any given interval of time depends solely upon the size of the apparatus.*

The oxygen can be received in a gasometer by means of the tube D, or into a graduated tube. In the latter case the apparatus appears capable of being transformed into an excellent *actinometer*: the number of divisions (cubic centimetres of gas) taken on the graduated tube every day from 8 to 9, or 12 to 1, giving the exact measure of the actinism for the day in question. But the present form of the apparatus is not suitable for this purpose; for, sup-

posing there were five hundred thousand distinct individuals of *P. pulustris* present in the flask on any given day, this number might be six hundred thousand or more on the following day, and so the results would not be comparable.

The small dead poplar branches form a very convenient medium for transferring the *Protococcus* from one flask to another (for instance, when the flask first used becomes dull or opaque and requires cleaning). Having been exposed to the rain for a long period of time they are invariably covered with *P. pluvialis* and *P. palustris*, though the presence of these minute plants is not easily recognised, and when placed in pump-water exposed to the light, the latter develop rapidly, and multiply enormously during the whole year.

Two analyses of the gas produced by *Protococcus pluvialis* and *P. palustris* in these experiments gave me :—

Oxygen = 98·7 and 98·0 per cent.

London, Oct. 20, 1883.

APPARATUS FOR ESTIMATING CARBON IN STEELS.

By ADDISON B. CLEMENCE.

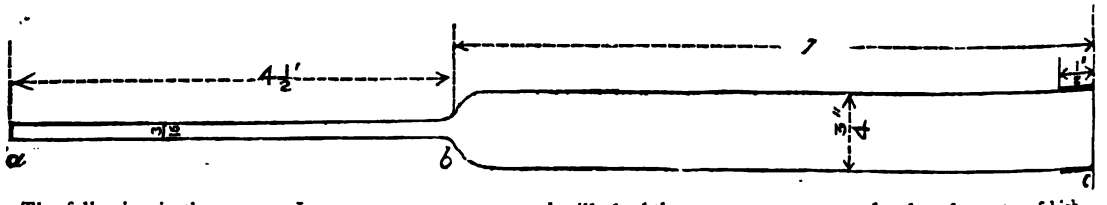
A description of the apparatus in use at the works of the Washburn and Moen Manufacturing Co., of this city, will, I think, be of interest to those who desire an accurate method for the estimation of carbon in steels. The apparatus has been in use in the works for the past three months, and has given entire satisfaction.

The method of filtering the carbon on to asbestos in a glass funnel, drying, transferring to a porcelain tube, and burning in a stream of oxygen gas, is accurate if all the carbon can be separated from the sides of the funnel, which, in some cases, is almost impossible.

Again, the method of filtering on to asbestos in a platinum tube or boat-shaped apparatus, and putting all in a porcelain tube, and burning as before, has also been used, and, of course, is less liable to error.

My aim has been to do away entirely with the porcelain tube and combustion furnace, and to filter and burn in the same tube.

The sketch shows the form of apparatus I have adopted, being made of platinum.



The following is the process I use :—

Dissolve from 3 to 5 grms. of the borings in double chloride of copper and ammonium, using 36 grms. of the salt to 120 c.c. water for 3 grms. of steel. After the separated copper is completely dissolved, filter on to a plug of asbestos placed at *b*, and wash thoroughly with hot water. Any carbon that adheres to the sides of the tube may be swept down by moistened asbestos. The tube is then placed in an air-bath, and dried at a temperature of from 150° to 175° C. for about one hour. A hard rubber cork, through which is passed glass tube, is inserted at *c*, the oxygen gas passing from *c* to *a*. Around the tube at *c* is a single thickness of filter-paper, about two inches wide, kept wet by a stream of water supplied by a reservoir on a shelf above. Heat is applied at *b* for one-half hour, at the end of which time the potash bulb is ready for the balance. One Bunsen burner is sufficient for the combustion. The same precautions are taken to dry the gas before entering the platinum tube, as well as before entering the potash bulb, as in the case with the porcelain tube method.

Six burners of a combustion furnace will consume 14 ft. of gas in one-half hour, while one Bunsen burner will consume 2 ft. in the same time.

The following table shows some results obtained by the "platinum tube" process :—

A, is a Swedish Bessemer containing 0·10 per cent of carbon.

B, an American Bessemer, with 0·18 per cent, and

C, an American Bessemer with 0·50 per cent.

All obtained by the "porcelain tube" process.

	A.	B.	C.
1.	0·09	0·18	0·49
2.	0·10	0·18	0·51
3.	0·10	0·16	0·49
4.	0·10	0·17	0·44

Note.—If pure closely-woven asbestos cloth can be obtained, I see no reason why, with two potash bulbs, twelve combustions may not be made in one day, for each filter with its contents may, when dried, be put in the platinum tube and burned.

Washburn and Moen Manufacturing Co.,
Worcester, Mass., U.S.A., Sept., 1883.

APPLICATION OF THE FUNDAMENTAL LAWS OF PHYSICS TO CHEMISTRY.*

By Prof. W. C. WITTMER.

There are in nature two distinct inert substances, and whatever is described in chemical text-books under the name of the chemical elements is always a combination of the above two substances. One of them is that which is known by physicists as luminiferous ether, and to the other I have given the provisional name of mass substance. For the present each of the two elements must be supposed as existing in the form of small spheres. As regards the ether spheres there is for the present no reason for assuming a difference in their magnitude or in their proportion of inert substance. As regards the mass spheres we must admit as many distinct formations and different quantities of the inert mass contained in the spheres as there are elements enumerated in chemical treatises. It will doubtless appear as regards the elements of high atomic weights that they are compounds of others of lower atomic weights, but for the present nothing decisive can be said on this point.

Both elements obey the following laws :—

1. Between the homogeneous there is mutual repulsion; between the heterogeneous mutual attraction.

2. All forces decrease inversely as the square of the distance.

According to existing determinations a molecule of the ether is able to neutralise as much mass-substance as is contained in 19·8 atoms of hydrogen.

If a mass-sphere of the magnitude of a hydrogen atom is found in space filled with ether, an ether atom combines with it in such a manner that both spheres approach up to contact. If we represent the particle of ether by a smal

* A Paper read before the Freiburg Meeting of German Naturalists and Physcians.

circle and the mass particle by a larger circle then an atom of hydrogen is represented by oO. Both spheres act now upon the surrounding ether each in its direction, and on that side of the mass-sphere which is turned away from the ether particle there will be that particle of ether which approaches nearest the combination, because the action of the particle of ether already taken up is here feeblest on account of the greater distance.

If the mass-atom grows, or if it is replaced by a larger one, the second particle of ether approaches more and more, and when the mass-particle m has reached five-fold the magnitude of hydrogen, a second ether-particle is taken up in addition to the first. The atom has then the form oOo.

When the mass-sphere is seven times as large as that of hydrogen there are consequently two particles of ether in immediate combination with the mass-sphere, and the external action of the combination is especially an ether-action of which only $\frac{7}{19{\cdot}8}$ are neutralised by the mass particles. We have thus the strongly electro-positive lithium. By the further growth of the mass-sphere the predominance of the ether-action decreases more and more, and in like manner the positive character of the elements. When m is 19 times as large as in H the minimum of the ether-action is reached, and we have the negative fluorine. If m still increases, it takes up, between 19 and 23, a third particle of ether, and hence in the next element, sodium, there is again a predominance of the ether-action, whence sodium is strongly electro-positive. The arrangement of the constituents is then—

o
oOo

If m still increases, the predominance of the ether-action decreases, the electro-positive character of the element is lost, and at 35·5 we reach the electro-negative chlorine. Between 35·5 and 39 a fourth particle of ether is taken up, and potassium is again strongly electro-positive. Between chromium and manganese a fifth ether-particle is taken up, and between bromine and rubidium a sixth, and so onward. From the electro-positive elements of a series there is a gradual transition to the electro-negative as the value of m rises, whilst there is an abrupt transition from the most electro-negative element of one series to the most electro-positive element of the next.

Proceeding from these principles chemical processes may be calculated as well as the physical and the astronomical, though on account of the many factors to be taken into account the calculations are tedious and complicated. In a separate treatise, "The Molecular Laws," I have deduced the laws which govern the material world, and in a series of papers which have appeared in *Schlömilch's Zeitschrift für Mathematik und Physik*, I have given the calculations for the elements hydrogen, oxygen, potassium, sodium, lithium, chlorine, and their simple compounds. It may thus be proved that the atoms of hydrogen, oxygen, and chlorine have the disposition to form molecules by uniting in pairs; that oxygen and chlorine readily unite with the alkaline metals, but not with each other, &c.—*Chemiker Zeitung* (*Cœthen*).

CHEMICAL EXAMINATIONS OF THE WATER OF THE BRINE-SPRINGS OF STOKE PRIOR, WORCESTERSHIRE.

By A. B. GRIFFITHS, M.A., Ph.D., F.C.S., Medallist in Chemistry and Botany, &c.

These brine-springs of Stoke Prior, near Bromsgrove, are the property of Mr. John Corbett, M.P., whose extensive works (one of the finest and largest in the kingdom) I had the pleasure of visiting several times this summer. The deposits of rock-salt in this neighbourhood, like most, if not all, the English deposits, exist in the Lias or upper members of the New Red Sandstone formations.

The following are the results of some recent analyses by myself of this brine (which is pumped up from a depth of over 300 feet). I also give the results of the analyses of this brine by the late Mr. A. Beauchamp Northcote, F.C.S., which he published in the *Philosophical Magazine* for January, 1855 —

	Analysis by Mr. A. B. Northcote, F.C.S. (1854).	Analyses by Dr. A. B. Griffiths (1883). I.	II.
	Per cent.	Per cent.	Per cent.
Soda	13·7779	13·7741	13·7752
Lime	0·1075	0·1092	0·1085
Magnesia	0·0165	0·0159	0·0173
Ferric oxide	trace	trace	trace
Chlorine	15·4697	15·4620	15·4683
Phosphoric acid	trace	trace	trace
Silicic acid	trace	trace	trace
Lithium	—	trace	trace
Bromine	trace	trace	trace
Potash	trace	trace	trace
Sulphuric acid	0·4888	0·4890	0·4892

The percentage of sodium chloride is 25·49; therefore the brine is a saturated solution of sodium chloride, and its specific gravity is 1·2049 at 24° C.

ON THE PROBABILITY OF A TRANSFORMATION OF STRYCHNINE IN THE ANIMAL ORGANISM AND ON AN OXIDATION PRODUCT OBTAINED FROM STRYCHNINE ON TREATMENT WITH POTASSIUM PERMANGANATE.

By Prof. PLUGGE.

The question whether the alkaloids undergo any change in the organism and especially as regards strychnine, has been some times affirmed and again distinctly denied.

The number of cases in which strychnine could not be discovered in the bodies of poisoned persons, or in the urine after the ingestion of medicinal doses, is very large.

The opposite results of many chemists, who have detected strychnine in the blood, the liver, the kidneys, and the urine, prove merely that in many cases strychnine may be found in these substances. But they fail to disprove a decomposition of strychnine in the organism; they show that a portion of undecomposed alkaloid is present, but they can never prove that another portion has not been decomposed. Kerner (*Pflüger's Archiv.*, ii., 20, and iii., 30), proved that after the use of quinine, a part of this alkaloid appears unaltered in the urine, whilst another portion becomes di-hydroxyl-quinine, a compound which is also obtained by treating quinine with permanganate in certain proportions.

The possibility of an analogous result with strychnine led to the following experiments:—

Strychnine was *given* to different animals, and their tissues, blood, and urine were then examined for an oxidation-product bearing the same relation to strychnine as does di-hydroxyl-quinine to quinine.

The attempt was made to obtain a product similar to di-hydroxyl-quinine by treating strychnine with permanganate.

The results obtained in the first set of experiments are of such a nature as to indicate an essential decomposition of strychnine in the organism, though the investigation is not yet completed.

The second set of experiments have given decisive results. The body obtained by treatment with permanganate is amorphous, of a yellowish-brown or

light-grey colour, sparingly soluble in cold, but more freely in hot water, from which it is partially re-deposited on cooling. It is readily soluble in alcohol, sparingly in ether and chloroform, very readily in dilute aqueous alkaline solutions, whence it is incompletely re-precipitated by the addition of hydrochloric acid.

That this body has in a great degree lost the properties of an alkaloid appears from the fact that it is not precipitated by phospho-tungstic and phospho-molybdic acid, iodised potassium iodide, potassium cadmium iodide, potassium-mercury iodide, &c.

If the strychnine derivative is treated with potassium-dichromate and sulphuric acid a splendid red-violet colour appears, whilst with strychnine there is formed first a blue-violet colour, which afterwards turns to a reddish violet. The change of colour in the strychnine reaction depends on a permanent oxidation of the alkaloid.

The strychnine derivative is not bitter and not poisonous. It may be regarded as strychnic acid, being preliminarily represented by the formula $C_{11}H_{11}NO_3,H_2O$.—*Arch. Pharm. and Chemiger Zeitung Cœthen.*

POSSIBLE VARIABILITY OF THE LAW OF DEFINITE PROPORTIONS.

By Professor J. P. COOKE.

IN the July number of the *American Journal of Science* (page 63), Professor Barker has given a very full summary of the views of Boutlerow on this subject, which have been recently presented to the Chemical Society of Paris by Wurtz, and emphatically endorsed in the discussion which followed by Schutzenberger. The opinion was then and there clearly expressed that the "chemical value" of a constant weight (or rather mass) of a substance might vary, and that the so-called atomic weight of an element might be simply the carrier of a certain amount of chemical energy which is variable within narrow limits; and further the question was asked whether "Prout's hypothesis may not be a true law which, like that of Mariotte, admits of a limited variation." Moreover numerous facts were cited, chiefly results of quantitative analysis, which seemed to confirm the views thus expressed. Such opinions are certainly very revolutionary, and, if they prevail, must entirely change the fundamental conceptions of chemical philosphy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses we call atoms, but must be considered as the "reciprocal saturation" or "interpenetration" of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is inconsistent with the atomic theory and with the superstructure which modern chemistry has built upon it.

In the connection above referred to it is stated that Boutlerow had held the views then advanced for the past three years. Such views are, however, by no means new. They were not only expressed, but fully worked out, by the writer more than twenty-five years ago. They were presented to the American Academy of Arts and Sciences in 1855 and fully developed in a paper published in the Memoirs of this Academy (New Series, vol. v., p. 337) "On Two New Crystalline Compounds of Zinc and Antimony and on the Cause of the Variation of Composition observed in their Crystals." The same subject was also discussed in a paper published in the same Journal, "On an Apparent Perturbation of the Law of Definite Proportions observed in the Compounds of Zinc and Antimony" (Second Series), vol. xx., 1855). In these papers the opinions now under discussion were brought forward, not simply as speculations, but as a legitimate theory, which was advanced to explain the facts observed in a long and laborious investigation of the order of the variation in the composition of certain well-defined crystals, obtained by the author from alloys of zinc and antimony of different percentage composition by the "method of fusion." Alloys were crystallised differing from one-half to five per cent, according to circumstances, from the alloy containing 95 per cent of zinc to that containing 95 per cent of antimony, and analyses were made of the crystals thus obtained. Two well-marked types of crystals, and only two, were obtained corresponding to the composition Sb_2Zn_2 and Sb_2Zn_3; but it was found that while crystals of the first type might be made either with an excess of zinc or an excess of antimony, the crystals of the second type would only take an excess of zinc; and the whole order of the phenomena indicated—first, the action of a force tending to unite the metals in one of two definite proportions; secondly, the effect of the excess of one or the other metal in the alloy tending to disturb this result; thirdly, the interference of the two compounds with each other in alloys of intermediate composition. The results were plotted and a curve drawn showing the order of the variation, and this curve indicates plainly—first, the strong tendency of the chemical force, and secondly the disturbing effect of the excess of either metal in the alloy. Moreover, the manner in which these two influences modified each the other's action seemed to preclude the supposition that the results could be the effect of a simple mechanical enclosure by the growing crystals. For all these details we must refer to the paper cited. We will only quote a few sentences which indicate the drift of the writer's opinions at the time.

"In the absence of any known principle of chemical science by which the remarkable variations of composition that have been demonstrated in this memoir can be explained, the conclusion is almost forced upon us that zinc and antimony are capable of uniting and producing definite crystalline forms in other proportions than those of their chemical equivalents; in other words, that the law of definite proportions is not so absolute as has been hitherto supposed."

"Accepting the view of the subject that has been offered, it will be obvious that the very large extent of the variation in the compounds of zinc and antimony is due to the very weak affinity between these elements. Were the chemical force stronger in proportion to the disturbing force, the variation would be lessened; were it weaker, the variation would be increased."

"To what extent this perturbation of the law of definite proportions prevails among chemical compounds, it must remain for future investigation to determine. There are, however, a number of facts which tend to prove that it is very general whenever chemical affinity is weak." Examples are cited in the memoir.

"If variations in composition of such magnitude are possible when the force of chemical affinity is weak, it is highly probable that some variation may occur when the force is strong; and whatever view may be taken of the cause of the variation, it will now become a matter of importance to ascertain whether many discrepancies of analysis hitherto referred to imperfections in the process may not be owing to the same cause which influences the composition of the crystals of the antimonides of zinc.

"The definite proportions I regard as a maximum toward which the chemical force strives, a maximum from which the deviations in most cases are small, although in others they may be very large; and I maintain that this view of the subject, which the memoir has aim to establish, is supported by the analogies of nature.

"I have shown in a former memoir that these numbers" (the equivalent numbers) "may be connected by a very simple numerical law, but here, as in other cases, we find merely a tendency towards the law, not an absolute agreement with it, the differences between the theoretical and the experimental equivalents being in many cases too great to be covered by errors of observation. The present memoir may throw light upon these discrepancies: for, to say the least, it is possible that the differences may originate in variations of the equivalent itself, and that the

theoretical equivalent may be the maximum towards which the chemical force tends."

In a subsequent paper entitled "Crystalline Form not necessarily an Indication of Definite Chemical Composition, or on the Possible Variation of Constitution in a Mineral Species independent of the Phenomena of Isomorphism," published in the *Philosophical Magazine* (June, 1860), during a visit to London, the writer shows that whatever explanation may be given of the variations of composition, which he had previously described, such variations must necessarily modify the composition of many crystalline mineral products. Examples are cited in which this is obviously the case, and it was proposed to designate by the word "Allomerism" "a variation in the proportions of the constituents of a crystallised compound without any change in the crystalline form."

Now when after twenty-five years the same question is revived, although without any reference to previous work on the subject, and the same opinions are expressed under conditions more likely to give them currency, it becomes interesting to enquire whether the progress of chemistry during the interval has tended to confirm or invalidate these views. So far as the writer is aware no investigation except his own already referred to, has been directed to the exact spot in question, and in none of the analytical results which have been more recently cited as possible examples of variation in the combining proportions has it had been conclusively shown that the discrepancies may not result from causes such as will be considered below.

During the last twenty-five years, however, a more extended knowledge has been acquired of that class of indefinite chemical compounds which like the alloys seem to occupy an intermediate position between definite composition and solution. Such compounds, for example, as many of the hydrates and silicates in which it is impossible to mark the limits between chemical and mechanical action. As in the case of the crystalline compounds of zinc and antimony, so in all such cases, some mechanical action—such as is manifested in what we call solvent power—seems to modify the chemical force: but in no case except the first has any attempt been made to investigate the interaction of the two. The atomic theory explains such cases of indefinite combination by distinguishing between atomic and molecular union, and it regards the complex products as resulting from an aggregation of dissimular molecules, in each of which, however, the law of definite proportion rigorously holds. It is necessary, however, in many cases to assume the existence of very complex molecules, and the doctrine of interpenetration certainly gives a simpler conception of this class of phenomena.

On the other hand, the extension of our knowledge has either brought to light new facts or given prominence to old ones, which, by explaining anomalies, have tended to confirm the atomic theory. It has been found that crystals have a very remarkable power of enclosing foreign materials in their structure, so that at times the crystallising material forms but a small portion of the resulting mass. If a crystal may enclose material wholly foreign to its composition, why may it not enclose an excess of either of its ingredients? There can be no doubt that in such cases the amount of material thus enclosed depends to a greater or less extent on the chemical force, and there is a continuity in the composition of the products which makes it difficult to distinguish between the material controlled by the chemical force and that which is not, and gives at least the appearance that the amount so controlled may be variable.

On the assumption, however, of the existence of molecules and atoms it is a very probable hypothesis, that when we bring together in solution or in fusion substances capable of yielding definite compounds, the number of molecules of such compounds that would form *at any one time* must depend—certainly among other conditions—on the strength of the chemical force as well as on the proportion of the several materials present. When, now, crystals form in such a menstruum we should expect that while the molecules of the definite compound would aggregate together, the crystalline structure thus formed would enclose, to a greater or less extent, molecules of one or the other of the constituents of this compound if present in excess, and the amount of such enclosure must depend on the relative proportion of the molecules in the menstruum; and this proportion, as we have seen, must have been already determined by the strength of the chemical force. Thus might arise such a regulated variation of composition as the writer's investigation indicated. The extent of the formation of molecules of definite composition in the menstruum would obviously be regulated by conditions whose action would determine no break of continuity; but the segregation of these molecules in the formation of crystals would cause at once a sudden change. Crystallisation is always a break of continuity, and although the crystalline structure may, as we have seen, enclose foreign material to a very large extent, yet, as the writer's investigation proved, there is always, even in extreme cases, a tendency to exclude such material, a tendency which is the more effectual in proportion as the crystalline molecules preponderate in the menstruum. Hence it is that by repeated crystallisation perfect purity may, in most cases at least, be secured. The hydrates of sulphuric acid furnish a good illustration of the theory we are discussing. Water and oil of vitriol may be mixed in any proportion and there is a perfect continuity between the various stages of dilution. When, however, on exposure to cold the definite hydrate $H_2SO_4.H_2O$ crystallises out, this continuity is abruptly broken, and it is reasonable to suppose that the molecules of this compound pre-existed in the liquid and only aggregated in the process of crystallisation. These crystals may be obtained between quite wide limits of dilution, and must enclose more or less of the menstruum, and, therefore vary in composition to a limited extent; but the definite hydrate can be obtained pure by repeated crystallisation.

Another class of facts bearing on the same subject has been forced upon the writer's attention during the last few years by the investigations he has undertaken on the revision of the atomic weights. In a memoir on the "Numerical Relations between the Atomic Weights," which he communicated to the American Academy of Arts and Sciences, February 28th, 1854, he remarked—as the result of a careful discussion of the determinations which had been made up to that time—that the constant errors "seem to be the great errors in all these determinations, those accidental errors which were made in the repetitions of the same process by equally careful experimenters being comparatively insignificant." The writer's subsequent experience has entirely confirmed this opinion.

Of these constant errors by far the most important are those due to impurity of material, whether in the substance analysed or in the products of the analysis. No problem of chemistry is more difficult than to prove that the materials and products involved in atomic weight determinations are perfectly pure, and represent a condition in which the elements are united in the definite proportions sought. It is of course very easy to discover such impurities as can be detected by well-known analytical processes. But how can you be sure that a given oxide, sulphide, chloride, bromide, or iodide, does not contain a similar compound of a lower or higher order? How can you be sure that either of these compounds does not contain a small amount of oxide? It is such impurities as these that are the chief source of uncertainty, and they cause variations of composition precisely similar to those discussed above. By referring to the examples cited on page 65 of this volume it will be found that they are for the most part, if not all, open to a suspicion of errors of this kind, and until these suspicions are removed the evidence which the alleged discrepancies furnish is not trustworthy. As a rule, when a substance is formed by a simple

reaction from perfectly pure materials, the purity of the product is taken for granted, and yet the writer as shown that sulphide of antimony, when precipitated by hydric sulphide from tartaric acid solutions acidified by hydrochloric acid, invariably contains more or less oxychloride of antimony, which leaves its equivalent or oxide of antimony when the sulphide is dried at 200° C. So also he found it impracticable to prepare chloride of antimony free from oxide.

It may then well be asked what proof can we have of purity in such cases as have been discussed beyond the very definiteness of composition which is in question? Before attempting to answer this question the writer would call attention to the fact that constancy of analytical results affords no certain criterion of purity. In the writer's own experience constancy of results has frequently meant nothing but constancy of impurity, and the allusion caused by coincidences so-called has been forced again and again on the writer's attention. Hence no valuable conclusion can be reached by attempting to combine, according to the method of least squares, results of atomic weight determinations made by different chemical processes. The writer undertook such a discussion, as stated in his early memoir on the relations of the atomic weights, above referred to, but abandoned it simply because accidental errors are the only ones which such mathematical methods can eliminate, and these were found to be quite insignificant factors in the problem. No useful conclusion can be deduced by comparing different classes of results, each affected by unknown constant errors; for it is impossible to assign to them correct values, and in comparison with results from which constant errors have been eliminated they are worthless. For example, in the writer's published work on the atomic weight of antimony, although a closely accurate result was obtained by the synthesis of the sulphide of antimony, this result is of no value in comparison with that obtained subsequently from the analysis of bromide of antimony, and to assign it any value in a discussion of probable errors would lead to error.

If now the question is still pressed: what is the criterion of a pure and definite compound? the only explicit answer that can be given is that a substance obtained by repeated crystallisations offers the most uniformly satisfactory evidence of purity that we possess. It is well known, however, that repeated crystallisations will not always ensure purity, and that very frequently the crystals, though pure when formed, cannot be collected and preserved without change. Moreover, it is seldom the case that such repeated crystallisations are possible. In most instances we must rely on other criteria of purity, such as constancy of physical properties like the melting- or boiling-points, and often the question can only be answered by a special, frequently a difficult, investigation. Indeed herein lie the great obstacles which we meet in all attempts to fix with accuracy the values of the atomic weights, and good judgment is the only criterion on which we can always depend.

It is surprising how few substances fulfil the conditions required in an accurate atomic weight determination, rarely more than one compound of each elementary substance; and for some of the most common elements, so far as we yet know, not even one. After the process has once been worked out, the actual analytical work is generally readily accomplished and the accidental errors involved are comparatively small; and when the constant errors have all been eliminated the definiteness of the results is surprising; and cannot but produce in the analyst a confidence in the definiteness of the law which determines such effects. With the writer, while his earlier work on crystalline alloys left an impression of the possible indefiniteness (under certain conditions) of chemical combination, his later work on atomic weights has shown him the exceedingly definite aspects of the same phenomena. Moreover, he has not found any evidence that the definiteness of chemical combination diminishes as the chemical force is weakened, a result we should expect if a variation were possible and as was predicted in the memoirs that have been so often cited. On the contrary, the writer has found that when purity is secured the proportions are as definite in weak compounds as in strong, in oxide of silver as in water; only with weak compounds it is usually more difficult to ensure purity.

While, therefore, the writer feels that the weight of evidence is at present in favour of the atomic theory, and of that absolute definiteness of combining proportions which this theory involves, still he is very glad that the whole question has been reopened in such an authoritative way as is likely to lead to its solution. His own investigations, now in progress, will have a direct bearing upon it, and until the requisite facts have been established there is no sufficient ground for a positive opinion. But, although it must be admitted that the atomic theory is the only basis on which a consistent philosophy of chemistry can at present be built, the writer must confess that he is rather drawn to that view of nature which refers all differences between substances to dynamical causes, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind.—*American Journal of Science.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

PHOSPHORUS.

THE material from which we are to calculate the atomic weight of phosphorus is by no means abundant. Berzelius, in his Lehrbuch,† adduces only his own experiments upon the precipitation of gold by phosphorus, and ignores all the earlier work relating to the composition of the phosphates. These experiments we will consider with reference to gold.

Pelouze,‡ in a single titration of phosphorus trichloride with a standard solution of silver, obtained a wholly erroneous result; and Jacquelain,‖ in his similar experments, did even worse. Schrötter's criticism upon Jacquelain sufficiently disposes of the latter.§

There are, in short, but two investigations upon the atomic weight of phosphorus which have any value for present purposes, namely, the researches of Schrötter and of Dumas. These chemists worked with different materials and by different methods, and yet obtained beautifully concordant results.

Schrötter¶ burned pure amorphous phosphorus in dry oxygen, and weighed the pentoxide thus formed. One grm. of P yielded P_2O_5 in the following proportions:—

2·28909
2·28783
2·29300
2·28831
2·29040
2·28788
2·28848
2·28856
2·28959
2·28872

Mean 2·289186 ± 0·00033

Hence P = 30·9562 ± 0·0074.

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† 5th Ed., 1188.
‡ *Comptes Rendus*, 20, 1047.
‖ *Comptes Rendus*, 33, 693.
§ *Journ. f. Pract. Chem.*, 57, 315.
¶ *Journ. f. Pract. Chem.*, 53, 435. 1851.

Dumas* prepared pure phosphorus trichloride by the action of dry chlorine upon red phosphorus. The portion used in his experiments boiled between 76° and 78°. This was titrated with a standard solution of silver in the usual manner. Dumas publishes weights, from which I calculate the figures given in the third column, representing the quantity of trichloride proportional to 100 parts of silver :—

1·787 grms.	PCl_3 =	4·208 grms.	Ag	42·4667
1·466	,,	3·454	,,	42·4435
2·056	,,	4·844	,,	42·4443
2·925	,,	6·890	,,	42·4528
3·220	,,	7·582	,,	42·4690
			Mean	42·4553 ± 0·0036

Hence P = 31·0314 ± 0·0467.

Now, combining these two values, we have :—

By Schrötter	P = 30·9562	± 0·0074
By Dumas	,, = 31·0314	0·0467
General mean	,, = 30·9580	± 0·0073

If O = 16, this becomes 31·0292.

The fact here noticable, that Dumas' figures give a value for P slightly higher than that deduced from those of Schrötter, may be accounted for upon the supposition that the phosphorus trichloride contained traces of oxychloride. Such an impurity would tend to raise the apparent atomic weight of phosphorus, and its occurrence is by no means improbable.

A RECALCULATION OF THE ATOMIC WEIGHTS FROM THE ORGINAL NUMBERS.†

LOTHAR MEYER, as he states in his preface to this work, had begun in 1867 to recalculate, according to a uniform method, all the determinations of atomic weights which had been made up to that time and were still serviceable; while K. Seubert has treated in the same way all those more recent than 1868, and has arranged for publication the whole of the material. Shortly before the completion of this laborious work, F. W. Clarke's book on the same subject appeared, but the authors believed, with justice, that this should not prevent the publication of their work; for not only is the manner in which they have arranged and set out their material totally different, but the results also are not in every case identical with those of Clarke, although in most instances they differ but little. The values which agree in the two books will therefore be all the more reliable.

In making the calculations the value of the individual experiments has been most carefully tested, and those not to be depended on or proved to be incorrect have been either altogether discarded or else not calculated out. The authors have also all through avoided the method of least squares, as being in most cases delusive. Where it was possible and seemed necessary the apparent weight obtained by weighing in the air has been reduced to the actual weight. There is, in conclusion, a synoptical table of all the calculations, together with short critical remarks on the value of the results obtained. The following is taken from these :—

On looking over the atomic weights it will be seen that the ratio of the two units O and H, and also the atomic weight of oxygen to 0·5 per cent, have been accurately determined. Should, however, this ratio be found at some future time to be incorrect, then all those numbers referred to H as unity would require to be changed accordingly.

The following table contains the most reliable figures; and all values whose possible error lies between 0·01 and 0·5 H are denoted by (*a*) :—

NAME AND SYMBOL.		O = 1.	H = 1.
Aluminium.....	Al	*a* 1·694	*a* 27.04
Antimony	Sb	7·494	119·6
Arsenic	As	*a* 4·693	*a* 74·9
Barium	Ba	*a* 8·575	*a* 136·86
Beryllium	Be	*a* 0·569	*a* 9·08
Bismuth	Bi	13·00	207·5
Boron	B	*a* 0·683	*a* 10·9
Bromine.....	Br	*a* 4·997	*a* 79·76
Cadmium	Cd	*a* 7·00	*a* 111·7
Cæsium	Cs	*a* 8·315	*a* 132·7
Calcium	Ca	*a* 2·501	*a* 39·91
Carbon	C	*a* 0·7502	*a* 11·97
Cerium	Ce	8·847	141·2
Chlorine.....	Cl	*a* 2·2159	*a* 35·37
Chromium.....	Cr	3·284	52·45
Cobalt.....	Co	3·67	58·6
Copper	Cu	*a* 3·959	*a* 63·18
Decipium	Dp	?	?
Didymium.....	Di	9·09	146·0
Erbium	E	10·4	166·0
Fluorine.....	F	*a* 1·194	*a* 19·06
Gallium	Ga	*a* 4·38	69·9
Gold	Au	12·29	196·2
Hydrogen	H	*a* 0·06265	*a* 1·00
Indium	In	*a* 7·108	*a* 113·4
Iodine	I	*a* 7·9284	*a* 126·54
Iridium	Ir	*a* 12·06	*a* 192·5
Iron	Fe	*a* 3·501	*a* 55·88
Lanthanum	La	8·680	138·5
Lead	Pb	*a* 12·932	*a* 206·39
Lithium.....	Li	*a* 0·439	*a* 7·01
Magnesium	Mg	1·500	23·94
Manganese	Mn	3·43	54·8
Mercury	Hg	*a* 12·52	*a* 199·8
Molybdenum	Mo	*a* 6·01	*a* 95·9
Mosandrium.....	Ms	?	?
Nickel	Ni	3·67	58·6
Niobium (Columbium, Cb).....	Nb	5·87	93·7
Nitrogen	N	*a* 0·8779	*a* 14·01
Norwegium	Ng	?	?
Osmium	Os	12·2	195
Oxygen	O	*a* 1·00	*a* 15·96
Palladium.....	Pd	6·66	106·2
Phosphorus	P	*a* 1·940	*a* 30·96
Platinum	Pt	*a* 12·177	*a* 194·3
Potassium.....	K	*a* 2·446	*a* 39·03
Rhodium	Rh	6·52	104·1
Rubidium	Rb	*a* 5·34	*a* 85·2
Ruthenium	Ru	6·49	103·5
Samarium (Yβ ?) ..	Sa	?	?
Scandium.....	Sc	*a* 2·755	*a* 43·97
Selenium.....	Se	*a* 4·942	*a* 78·87
Silicon	Si	1·754	28·0
Silver	Ag	*a* 6·7456	*a* 107·66
Sodium.....	Na	*a* 1·4408	*a* 22·995
Strontium	Sr	*a* 5·47	*a* 87·3
Sulphur.....	S	*a* 2·0037	*a* 31·98
Tantalum.....	Ta	11·42	182
Tellurium.....	Te	8·00	127·7*
Terbium	Tb	?	?
Thallium	Tl	12·76	203·7
Thorium	Th	14·534	231·96
Thulium	Tm	?	?
Tin	Sn	7·353	117·35
Titanium.....	Ti	3·15	50·25
Uranium	U	15·03	239·8
Vanadium	V	*a* 3·20	*a* 51·1
Wolfram(Tungsten)	W	*a* 11·50	*a* 183·6
Yα and Yβ		?	?
Ytterbium.....	Yb	10·81	172·6
Yttrium.....	Y	5·61	89·6
Zinc	Zn	4·065	64·88
Zirconium	Zr	5·66	90·4

* Perhaps Te = 7·91; 126·3.

* *Ann. Chem. Pharm.*, 113, 29. 1860.

† "A Recalculation of the Atomic Weights from the Original Numbers," by Lothar Meyer and K. Seubert. Leipsic: 1883.

Among the atomic weights are some where the possible error does not exceed one to two-hundredths that of hydrogen, viz.:—

Na, K, Ag, C, N, O, S, Cl, Br, I.

Not exceeding 0·1 H:—

Li, Rb, Ca, B, Pb, P, V, S, Se.

Exact to at least 0·5 H:—

Cs, Cu, Be, Sr, Ba, Cd, Hg, Al, Sc, Ga, In, As, Se, Mo, W, Ir, Pt.

Incorrect from a half to a whole unit:—

Au, Mg, Zn, Si, Te, Cr, Mn, Co, Ni, Ru, Rh, Pd.

While, leaving out of account several very doubtful earth metals, we have the following in which the error may amount to several units (sometimes 20):—

C, La, Di, Y, Yb, E, Tl, Ti, Zr, Th, Sn, Sb, Nb, Ta, Bi, U, Os.

NOTICES OF BOOKS.

Plant Analysis: Qualitative and Quantitative. By G. Dragendorff, Ph.D., Professor of Pharmacy in the University of Dorpat. Translated from the German by H. G. Greenish, F.T.C. London: Baillière, Tindall, and Cox.

We have here a work of such exceptional value that it may well be said to "supply a want keenly felt by both English chemists and English Pharmacists."

The author's merit in this particular department of chemical science is well known to all who have had occasion to make use of his procedures for the detection of organic poisons, and we may therefore congratulate ourselves that his work has been made available to English students and experts in the present clear and accurate translation.

Professor Dragendorff fully recognises the difficulties of his subject as compared with mineral analysis. Nevertheless he has felt warranted in attempting the construction of a method that shall comprise at once both the qualitative and the quantitative, the micro- as well as the macro-chemical analysis of plants and their constituents. All widely distributed vegetable substances are to be included, the detection of rarer ones facilitated, and the method so arranged that other principles not hitherto observed shall, if present, attract the attention of the investigator.

The author agrees with earlier authorities in this department of analysis in separating the principles present into groups by the successive use of different solvents. He admits also that these solvents should be as indifferent as possible, but he increases their number and varies the order of their application.

Professor Dragendorff gives at the outset instructions for drying and pulverising—processes more difficult in this case than with inorganic matter, and for the determination of the ash.

He then proceeds to the successive application of the solvents. Petroleum spirit is first used to remove ethereal and fatty oils, wax, &c. Next follows ether—as free as possible from water and alcohol—in order to take up the resins and their allies. The residue is then treated with absolute alcohol in order to dissolve out tannins, bitter principles, alkaloids, &c. Next follows water which removes mucilage, saponin, acids, glucoses, and saccharoses. Afterwards comes treatment with dilute soda in order to extract metarabic acid, the albumenoids, phlobaphene, &c. Dilute hydrochloric acid is next used to remove starch, pararabine, calcium oxalate. Lastly comes the estimation of lignine and its allies and of cellulose.

The precautions to be taken in the use of the various solvents are explained in full, and instructions are given for separating the members of each group.

The remaining and larger portion of the work is devoted to special methods and supplementary notes. We may obtain a fair notion of the thoroughness of Prof. Dragendorff's instructions by looking a little more closely at the section on the estimation of tannin, and the supplemental remarks on the same subject. The author passes in review the process of Pribram, with neutral lead acetate, which yields a precipitate not of constant composition, though if the solution is not over-dilute and the washing is not too prolonged the tannin in sumac, divi-divi, myrolabans knoppern, oak-bark, and willow-bark "may generally be satisfactorily estimated. Gallo-tannic acid at times also yields good results."

Sackur's method with copper acetate gives inconstant results even with the same tannic acid. Stannous chloride and ammoniacal stannous chloride, recommended by Risler-Beunat and Persoz, precipitate most tannins slowly and incompletely. Tartar emetic, recommended by Gerland, for the volumetric determination of tannin, does not precipitate some forms of tannin at all. Ammoniacal solution of zinc acetate, ferric acetate, and ferric citrate, as proposed by Terreil, Handtke, and Wildenstein, fail also to give generally satisfactory results. Löwenthal's permanganate process yields results which are sufficiently accurate for technical purposes, though the solution must be very dilute. The chloride of lime process of the same author shows results in excess of the truth.

Mittenzwey's method, based on the absorption of oxygen by an alkaline solution of tannin, is rarely of any value. Wagner's method,—titration with cinchonine sulphate, using rosaniline acetate as an indicator—has, in the hands of most experimentalists, failed to give good results, as its fundamental assumption that magenta does not colour the liquid until all the tannin has been precipitated, does not hold good of all tannins. The gelatin process, with the addition of common salt and 1-10th vol. of hydrochloric acid (of sp. gr. 1·12), is sometimes available, but the proportions of tannin precipitable by 100 parts of gelatin, vary from 77 to 168. Attention is called to the fact that, under the name of tannin, are included bodies differing in their molecular weights, in their chemical effects, and in their constitutions. Some are decidedly glucosides and others decidedly not. The author advises that this point should always be carefully determined in tannins found on examining any unknown vegetable product.

The alkaloids, we need scarcely say, are worked out in a very elaborate manner. In the separation and recognition of the vegetable acids the author adopts to a great extent the methods recommended by Barfoed.

Cellulose Prof. Dragendorff does not consider to be absolutely invariable in its composition and properties. The cellulose of most phanerogamous plants is dissolved by ammonio-sulphate of copper (prepared by precipitating hydrate of copper from the solution of the sulphate by dilute caustic soda, rapidly filtering, pressing, and dissolving in the requisite quantity of 20 per cent solution of ammonia), but that of many fungi is either insoluble or taken up to a very slight extent only.

Among the useful features of this book must be mentioned a table of the empirical formulæ, and percentage composition of the vegetable constituents mentioned in the body of the work; another table of the more important of the same bodies, arranged according to their percentage of carbon, beginning with the lowest, a plate showing the spectra of the most important vegetable colouring matters, and a good index.

This book will speedily be recognised as an invaluable guide both in the chemical and the pharmaceutical laboratory.

Wheat from India.—M. Balland.—The author has found in sacks of wheat exported from Bombay a quantity of seeds, principally *Vicia peregrinum*, *Cicer arietinum*, and *Ervium uniflorum*.—*Comptes Rendus.*

CORRESPONDENCE.

CHEMICAL RESEARCH IN ENGLAND.

To the Editor of the Chemical News.

SIR.—The article on "Organic Chemistry," in *Nature* of Oct. 25th, must have set the minds of many chemists thinking over the present and future prospects of this science in England.

The author, however one-sided his views, points out clearly the want of original research in England. I should be obliged if you could find space for some remarks on this subject from one who has devoted some thought to it. The majority of English chemists, the younger men more especially, have to live by the pursuit of chemistry, either in teaching it, in applying it to the arts and manufactures, or as professional chemists. What benefit, at the present day, will either of these derive from, or what honour gain by original research? Little or none.

First, with regard to the teacher. The appointments of lecturer or teacher of chemistry at the Universities, Hospitals, and the Public Schools are always given to men who have a degree rather than to men who have shown any power of original research. If original research were made a *sine qua non* of a degree one could understand this. Many practical chemists know that men holding high honours in chemistry are often unable to perform even simple laboratory experiments. They know how to use their memories, but their hands are strangers to them. These examination men are the teachers of the present generation; they have done no original research, and they do not see the value of it. They have learnt or crammed what has been done in the past, and then start to teach or cram others. So original research and its value as an educational agent is ignored.

Secondly, as regards the practising chemist, whether in the arts or manufactures or as independent professional men. Most of these can claim only the letters F.C.S. after their name to distinguish them, and as this F.C.S. can be easily obtained by any man truly interested in chemistry, it has no value as a mark of distinction. Why does not the Chemical Society make a distinction between the Fellow who has done original research, and the man who is amply repaid for his subscription by the *Journal* and other advantages the Society offers? Then F.C.S. would be of value, and original research in England have a great stimulus given to it.

Nevertheless, I believe there is far more original research done in England than is generally supposed, but it is not made known, being applied quietly and privately to our arts and manufactures.

The author of the article does, unwittingly we must presume, great injury to English chemists. He tends to increase the notion, already too prevalent, that Germans are superior chemists to Englishmen. Already many of the best appointments in England are given to Germans, instead of to English chemists, and much original work done in England goes to swell German periodicals. I may be accused of partiality, but I believe that Englishmen are as good chemists as Germans. There are many English chemists who, finding that English appointments are given by preference to German Ph.D's, have transferred their energies into less biassed professions or businesses.

Whilst holding the strongest views as to the value of original research, I should be sorry to see English chemists following the example of the Germans. Much of the original research of German chemists is most trivial. An infinite number of minute points are dilated to an abnormal bulk. This does not represent true work, nor does it tend to those broad generalisations so desired, and the reduction of chemical facts to a manageable and intelligible form.

The Government, the Royal and Chemical Societies, and the British Association, all lend aid to promote original research. I cannot but think it a mistake that much of this money goes to men already in the receipt of good incomes, or even of independent means. These men ought surely to need no inducement to make them devote some of their time and means to original research. If the grants of money were in all cases £100 per annum given to younger men not making sufficient incomes to keep them, and at the same time enable them to devote time to original research, more work might be done, and with care in selecting men of ability good work would be also ensured.

I must apologise for thus trespassing on your space, but this subject is one, I believe, of importance to the scientific, educational, and industrial classes in England.—I am, &c.,

FREDK. JAS. LLOYD, F.C.S.

King's College,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 15, October 8, 1883.

Force of Explosives.—M. Berthelot.—The author gives a notice of a work which he has just published, and which gives a general theory of explosives, according to their chemical metamorphosis and their formation-heat.

The Co-existence, in a Specimen of Guano, of Ammonium Carbonate effervescing with Water and of Potassium Sulphate.—E. Chevreul.—The author thinks that sodium chloride, and especially potassium chloride, which he has found associated with ammonium hydrochlorate, may have an important influence upon vegetation.

Induction produced by the Variation of Intensity of the Electric Current in a Spherical Solenoid.—M. Quet.—A mathematical memoir, not capable of useful abstraction.

Products of the Fermentation of Cane-sugar induced by Arable Soil.—MM. Dehérain and Maquenne.—The ferments of arable soil acting upon cane-sugar at 35° in presence of calcium carbonate and with the exclusion of air furnish the following products:—Small quantities of ethylic alcohol and traces of the higher alcohols. Certain proportions of acetic, butyric, and propionic acids, the two former much more abundant than the latter.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 3.

Action of Phosphorus Chlorides upon Phenanthrenquinone.—B. Lachowicz.—Phosphorus pentachloride yields, with phenanthren-quinone, a new substance, phenanthren-dichlor-keton, $C_{14}H_8OCl_2$, besides phosphorus oxychloride and a resinous substance. Phosphorus trichloride yields also a new substance if allowed to act upon phenanthren quinone, but the author has not yet obtained it in sufficient quantity.

Allyl-succinic Acid and a Carbo-capro-lactonic Acid.—E. v. Hjelt.—The author obtains allyl-succinic acid from malonic ester. It closely resembles the propyl-succinic acid of Waltz.

Kreatinoid Compounds of the Aromatic Group.—Peter Griess.—An examination of the products obtained by the action of cyan-carbimid-amido-benzoic acid upon the aromatic amido and diamido compounds.

Preparation of Diphenylen-keton-oxide.—W. H. Perkin.—The author obtains this compound from the residue of the distillation of a mixture of salicylic acid with acetic anhydride.

The Diazo-derivatives of Nitro-benzyl-cyanide.—W. H. Perkin.—The author has obtained a compound, $C_{14}H_{10}N_4O_2$, by treating an alcoholic solution of nitro-benzyl-cyanide with alcoholic potassa, and adding an aqueous solution of diazo-benzol-chloride.

Molecular Magnitude of Iso-indol.—F. P. Treadwell and V. Meyer.—The authors obtained the figures 7·99 and 7·91, which agree with no formula.

Sulphocyan-propimine.—J. Tscherniac and C. H. Norton.—This compound is obtained by dissolving two parts ammonium sulphocyanide in 6 parts of hot ammonia at 90 per cent, adding 1 part of mono-chlor-acetone, and letting the mixture stand twenty-four hours. It is then filtered, washed with absolute alcohol, and the filtrate is distilled in the water-bath. The residue is dissolved in 4 parts of cold water, and allowed to stand for some days. The red liquid is freed from sediment by decantation, decolourised by repeated boiling with bone-black, and concentrated at 110°. The sulphocyanate of the base crystallises out.

Sulphocyan-acetone.—J. Tscherniac and R. Hellon.—The authors dissolve 175 parts of crystalline barium in 525 parts of alcohol, and add 100 parts of mono-chlor-acetone. After some days the mixture is filtered, the deposit washed with alcohol, the alcoholic liquid is concentrated on the water-bath, and leaves crude sulphocyan-acetone as a syrup. This is boiled in 10 parts of water; the solution is let stand twenty-four hours, when a thick stratum of tarry matter is deposited. The clear solution is decanted off, filtered, and concentrated on the water-bath. Sulphocyan-acetone falls to the bottom in the state of oily drops, and is washed with a little distilled water, and dried in a vacuum over sulphuric acid.

A New Industrial Method of obtaining Whole-stuff.—G. Archbold.—The author macerates wood or straw, cut into suitable pieces, in dilute milk of lime, after twelve hours introduces them into a suitable digestor, and saturates with sulphurous acid, the pressure amounting to four or five atmospheres. In two hours the material is so loosened up that after washing with water and further treatment under pressure with 3 per cent chloride of calcium and half per cent aluminium sulphate dissolved in a little water, the stuff obtained without any further operation has the appearance of cotton, and can serve for the manufacture of fine qualities of paper.

The Occurrence of Methylic Alcohol among the Products of the Dry Distillation of Resin.—W. Kelbe and J. Lwoff.—From 150 kilos. of resin the authors obtained 50 grms. of methylic alcohol.

The Conversion of the Nitriles into Imides. Behaviour of Hydrocyanic Acid and Ethylene Cyanide with Hydrochloric Acid and Alcohol.—A. Pinner.—On passing gaseous hydrochloric acid into a mixture of equivalent quantities of a nitrile and an alcohol, there is formed an amido-chlor-ether. This compound is very unstable, loses a molecule of hydrochloric acid, and is quickly converted into the hydrochlorate of the imido-ethers. The author has especially studied the formation of formimido-ether and succinimido-ether.

On I. IV. Diortho-nitro-anthraquinone, I. IV. Diortho-amido-anthraquinone, and a New Method for Preparing Anthra-rufine.—H. Rœmer.—For preparing anthra-rufine the dimido-compound is dissolved in an excess of concentrated sulphuric acid, water is added until a red paste is formed. When cold, potassium nitrite is added till a clear yellow solution appears, and the odour of nitrous acid is distinct. It is let stand a short time, diluted with water, and boiled, when dark yellow flocks are soon separated, with escape of gas. After boiling for about an hour the conversion is complete. The yellow compound dissolves almost completely in potassa with a reddish yellow colour. For further purification it is precipitated with hydrochloric acid; the precipitate boiled in baryta-water, and the crimson lake thus formed, is decomposed with hydrochloric acid. A pure, orange-yellow, crystalline product is thus obtained.

A New Non-saturated Acid Isomeric with Itaconic Acid.—R. Fittig and F. Rœder.—The authors caused ethylene bromide to act upon sodium malonic ether, and obtained the above acid, which melts at 139°.

Conversion of Non-saturated Acids into Isomeric Lactones.—R. Fittig.—This transformation is readily effected if the non-saturated acid is heated for a short time with dilute sulphuric acid.

Behaviour of the Lactones with Water.—R. Fittig.—The distinction between the author's δ-lactones and the ordinary lactones is not quite so great as he at first supposed. The latter, also, if boiled for some hours in a very dilute solution in a cohobator, yield an acid liquid, a part of the lactone being converted into the corresponding γ-oxy-acid.

Amido-phenoles.—F. Kalckhoff.—The author has obtained and analysed ortho-oxy-phenyl-urea and the corresponding para compound.

Moniteur Scientifique, Quesneville.
October, 1883.

Patents taken Abroad.—Specifications of German patents relating chiefly to colouring-matters.

Panary Fermentation.—G. Chicandard.—The author concludes that panary fermentation does not consist in a hydratation of starch followed by alcoholic fermentation. It is not determined by a *Saccharomyces*. The fermentable matter is the gluten which is rendered available for the microbia by means of a zymase which they secrete. This zymase renders it at first soluble, and then converts it into a peptone by hydration. The microbia assimilate this peptone, furnishing numerous products of excretion, carbonic, acetic, butyric, and lactic acids, hydrogen, nitrogen, alcohol, leucine, tyrosine, and phenol. Crude starch is not modified, either by the microbia or by their zymase; baking alone forms soluble starch, erythro-dextrines, and achroo-dextrines. These latter are found especially in the parts which have been most strongly heated. The agent of panary fermentation exists normally in the grain of wheat as a mobile sphœro-bacterium, *Microzyma glutinis*. It develops into *Bacillus glutinis*, and this change is accelerated by the soluble albumenoid matters which baker's yeast contains. Panary fermentation is produced whenever flour mixed with leven or yeast is brought in contact with water.

Picric Acid employed as a Reagent for Albumen and Sugar in Urine.—Dr. G. Johnson.—From the *Pharmaceutical Journal*.

The Resin Industry in the Landes.—A. Renard.—An interesting monograph, topographical, technical, and scientific, but too bulky to admit of abstraction.

Review of Foreign Researches in Organic Chemistry.—G. de Bechi.—A series of extracts from the *Berichte der Deutsch. Chem. Gesell.*

New Process for the Manufacture of Stuff for Paper.—L. Naudin.—This memoir consists essentially in an illustration showing the plant employed.

New Steam Bronze.—M. Balanche.—On adding a solution of potassium bichromate to one of manganese chloride, no precipitate is obtained, but if the neutral chromate is used there is an immediate bronze precipitate. Setting out with these facts the author has made up a colour with a mixture of potassium bichromate, manganese chloride, and sodium acetate. By the action of heat the sodium acetate is decomposed, the acid chromate neutralised, and the precipitate mentioned above is formed upon the cloth. The colour employed was:—

Bichromate	.. ..	100 grms.
Water	.. ..	850 ,,
White starch	.. ..	150 ,,

Boil, let cool, and add :—

Crystalline manganese chloride	..	210 ,,
Sodium acetate, 16½° B.	.. .. ..	210 ,,

The colour, when printed and steamed, gave a very intense bronze, scarcely affected by washing and soaping. The cloth was not affected. The same mixture, leaving out the starch, may be used for steeping cloth, and thus produces a bronze, which may be discharged by tin crystals and an acid. The author enquires whether the bronze is manganese peroxide or a sub-chromate.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., August, 1883.

This number is chiefly taken up with the announcement of prizes offered for inventions. Among these we find the moderate sum of 2000 francs proposed for the industrial application of oxygenated water; the same sum for the economic preparation of ozone; the same sum (!) for the fixation of the nitrogen of the air in the form of nitric acid, ammonia, or cyanogen; the same sum for the production from pyrites of sulphuric acid, absolutely free from arsenic. 1000 francs for a new industrial use of any cheap and plentiful mineral; the same sum for the utilisation of industrial residues; the same sum for a useful application of the newly discovered metals; the same sum for the new applications of non-metallic bodies, and the same sum for the discovery of a new alloy useful in the arts. Further, 3000 francs for the artificial production of graphite fit for pencils; the same sum for the artificial production of black compact diamond; 4000 francs for the discovery of processes capable of furnishing useful organic compounds, such as quinine, cane-sugar, &c.; 4000 francs for the artificial preparation of fatty acids or waxes; 1000 francs for improvements in the production and working of kelp-ash; 3000 francs for the production of steel or melted iron having special useful properties, by the incorporation of foreign metals. 2000 and 1000 francs respectively for the manufacture in France of fuming sulphuric acid and anhydrous sulphuric acid; 3000 francs for the utilisation of naphthaline in the manufacture of colours; 2000 francs for the substitution in dyeing, and especially in silk dyeing, of some non-destructive compound for sulphuric acid; 2000 francs for the discovery of a process for the utilisation of the tannin contained in barks, &c., not used in tannery, and 2000 francs for the industrial preparation of chlorine from the residues of the ammonia soda process.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Narcotic.—Perhaps some kindly disposed reader would give me a rapid and reliable method for the estimation of morphia and narcotine in opium. The only methods I know of require about two days to complete.—J. F.

Detection of Traces of Gold.—Would any of your readers be kind enough to tell me what is, or where I can find an account of, the best method of detecting small traces of gold in the presence of large quantities of iron?—J. C.

MEETINGS FOR THE WEEK

MONDAY, November 5th.—Royal Institution, 5. General Monthly Meeting.

SATURDAY, 10th.—Physical, 3. "Some Experiments on the Velocity of Sound in Air," by J. Blaikley. "On the Moment of a Compound Magnet," by R. H. M Bosanquet. "On Measurements relating to the Electric Resistance of the Skin, and to certain Medico-electric Appliances," by W. L. Carpenter

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Steam Superheaters improved or Oil Tar and Resin Refining.
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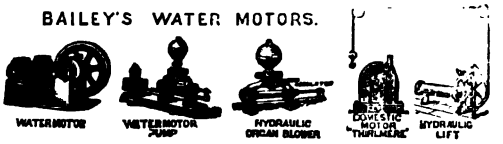

Silver Medal, Manchester, 1879; Blackburn, 1881.

WHAT THEY ARE DOING :—
The Water Motor blows Blacksmiths' Fires at Penmaenmawr.
The 2-horse Water Motor daily works Waggons up an incline at Edge Hill Collieries, Bolton, with success.
The *Brighton Guardian* is regularly printed by these Motors, giving the highest satisfaction.
The Lifts are in Hotels and Warehouses of Manchester, Dublin Liverpool, Lancaster, &c.
The "Thirlemere" drives a Grindstone at Bristol.
The 4-horse Water-Motor is at work Cutting Timber, by circular saw, 5 inches thick.
A 20-horse Water Motor, pumping for H. Vivian, Esq., M.P.
A 12-horse Water Motor, pumping at the Mine of G. N. Newdegate, Esq., M.P.

TESTIMONIALS.

June 22, 1881.—From H. H. Vivian, Esq., M.P.—"I have just heard that the Water Moto sent out last year is doing well."
Lord Salisbury's Clerk of Works writes:—"I am much pleased with the Water Motor, for it is most compact and useful."
From Messrs. Seed Brothers, Leather Merchants, Halifax:—"The Water Motor is doing its work well and quietly, and bids fair to answer our highest expectations."
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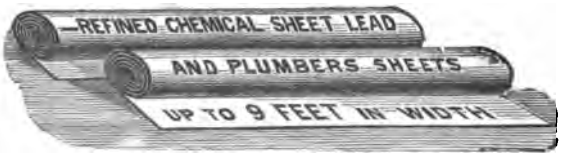

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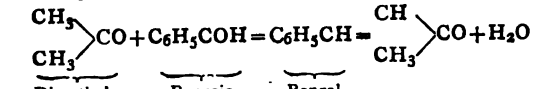
THE CHEMICAL NEWS.

Vol. XLVIII. No. 1250.

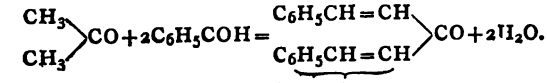
ON FURTHER CONDENSATION COMPOUNDS OF KETONES AND ALDEHYDS.

By A. C. PONDER.

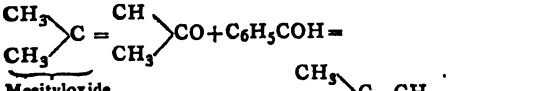
The examination of the condensation-products of aldehyds and ketones undertaken by Dr. Claissen,* Claparède,† and myself have shown that in ketones in which a CH_3 group is directly united to CO, a displacement of the elements of water readily takes place when the ketone is brought into contact with an aromatic aldehyd and a dehydrating agent. We obtained thus the following compounds:—



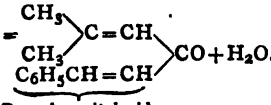
Dimethyl-acetone. Benzoic aldehyd. Benzal-acetone.



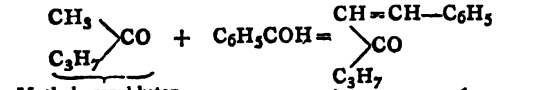
Dibenzal-acetone.



Mesityloxide.

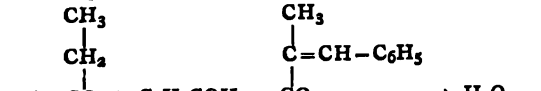


Benzal-mesityloxide.

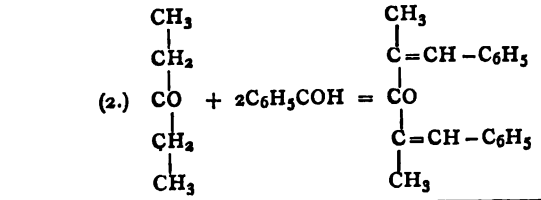


Methyl-propyl-keton. Benzal-methyl-propyl-keton.

It became then interesting to study the behaviour of ketones containing the radicle $R-CH_2-CO-CH_2-R$, *e.g.*, diethyl-ketone and dipropyl-ketone, to find, in fact, if the CH_2 or methylene group behaved as a CH_3 or methyl group, by which one would arrive at the following compounds, accordingly as one or two molecules of the aldehyd were employed.



Diethyl-keton.



* *Berl. Berichte.* i., 349.
† *Ibid.*, ii. 2460.

In my experiments with Dr. Claissen, a solution of soda as dehydrating agent was made use of containing 10 per cent of the alkalies, and the ketone and aldehyd were dissolved in diluted alcohol. This reacted in nearly all cases most successfully, the oily body which at first separated becoming hard and crystalline after the lapse of a few hours.

In applying the same means of condensation to a solution of dipropyl-ketone and benzoic aldehyd in weak alcholic solution the same reaction was observed, but on attempting to distil the oily body, which after many days had not become solid, decomposed into its constituents even when the distillation was conducted under diminished pressure. In employing hydrochloric acid gas we obtained somewhat better results, but the compound was very impure, and unfit for analysis.

I have, however, recently obtained conclusive evidence that a condensation takes place when sulphuric acid is employed as a dehydrant.

In my experiment I took diethyl-ketone (which is the more easily prepared of the two) and benzoic aldehyd in the proportion of two molecules of the aldehyd to one of the ketone. I dissolved both in a slight excess of glacial acetic acid, placed the vessel in a freezing mixture, and allowed strong sulphuric acid to drop slowly into it from a tap funnel, stirring the mixture all the time. There ensued at once a dark brown colouration, and the whole became gradually very thick and viscous. After standing some time it was poured into cold water, neutralised with soda, and ether added in excess. The ethereal solution was distilled to free it from the ether, and the oily red-brown liquid which remained behind left to itself. After some days I found that a mass of small scaly crystals had separated from the oil. These I collected together, and washed with ether. The melting-point was 107°. The amount, however, was unfortunately too small for analysis. I hope to experiment further on larger amounts, and satisfactorily isolate the compound.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE, AND THE INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

Microcosmic salt has been employed by me in this investigation. It can be purchased in a state of great purity, it can be accurately weighed, and the solution has no action on glass vessels. The water of crystallisation is a slight drawback.

If the salt is crushed, pressed between folds of filter-paper, and preserved in an accurately ground stoppered bottle, the stopper greased, constant results will be obtained with it for some time, but after a few months, if the bottle has been frequently opened, the phosphoric acid will come out on analysis a little too high, showing loss of volatile constituents has taken place.

Making up large volumes of solution was not found to answer, as whatever care was taken to preserve them they varied in strength before they were used up.

The salt employed was submitted to careful qualitative analysis, and I could detect no impurity; it was in the form of small crystals mostly detached, but partly aggregated in lumps.

A portion crushed fine and pressed between folds of filter-paper was weighed in a porcelain crucible; weight, 1·6528 grms.; left in open crucible on balance pan for 20 minutes, lost 0·0002 grm.; the total loss in one hour was only 0·0004 grm.

According to the atomic weights adopted by Miller, microcosmic salt on ignition should leave 48·8 per cent sodic metaphosphate and contains 33·97per cent phosphoric acid. 1·3735 grms. of the salt in its original condition ignited carefully in a Lawrence Smith crucible to constant weight, left a residue weighing 0·6698 grm. Theory requires 0·67027 grm.

A portion of the salt crushed and pressed, weighing 1·365 grms., ignited as above, left 0·6664 grm. residue. Theory requires 0·66644 grm.

A considerable quantity was crushed fine, pressed between folds of filter-paper, well mixed, and bottled Dec. 10th, 1882.

Another portion was crushed only, mixed and bottled December 24th, 1882.

A further portion was turned into a mortar, the lumps broken down, well mixed, and bottled April 29th, 1883.

Previously (November and April) some estimates were made with the salt in its orgiginal condition and with a small quantity that had been crushed and pressed.

I shall refer to the above as—

The salt crushed and pressed.
The salt crushed only.
The salt bruised and mixed.
The salt in its original condition.

In the earliest stage of the enquiry a large number of the experiments were made (most of them with another sample of microcosmic salt) which with few exceptions proved unreliable, sufficient precautions not having been taken to exclude error. As nearly all the work was gone over again, I shall only refer to the *results* of such of these earlier experiments as can be depended on.

The results recorded in this paper could not be conveniently arranged in the order in which they were obtained, but I have annexed the date when the experiments were made to each series.

Two ignition experiments made January 21st, 1883, with the salt crushed and pressed December 10th, 1882, gave the following results :—

No. 1. Salt taken, 1·9719 grms. : residue, 0·9624 grm. = 83·97 per cent P_2O_5.

No. 2. Salt taken, 1·9335 grms. : residue, 0·9440 grm. = 33·99 per cent P_2O_5.

Balances Employed.

A large Oertling, to carry one kilogramme and turning distinctly with 1 milligramme, used to weigh the solutions.

A smaller Oertling, to carry 100 grms. and turning distinctly with 1-tenth of a milligramme, used to weigh the salt and precipitates. Both very fine instruments in excellent order.

Reagents Employed.

These were very pure.

Magnesia Mixture No. 1.

1 c.c. contained—
0·0156 grm. magnesium chloride.
0·0825 grm. ammonium chloride.
0·0194 grm. ammonia (NH_3).

Magnesia Mixture No. 2.

1 c.c contained—
0·0312 grm. magnesium chloride.
0·1650 grm. ammonium chloride.
0·0127 grm. ammonia (NH_3).

Neutral Magnesia Mixture.

Made by heating a measured quantity of Mg. Mix. No. 1 to expel free NH_3 and making up to original volume with water.

Dilute Ammonia.

*No. 1 contained 6·34 per cent NH_3.
No. 2 „ 2·52 per cent „
No. 3 „ 1·20 per cent „

Stronger solution of ammonia containing 11·54 per cent NH_3.

Ammonium chloride.
Ammonium sulphate.
Ammonium oxalate.
Citric acid, a very fine sample.

Sol. ferric chloride, containing excess of HCl. 10 c.c gave 0·0322 grm. ferric oxide, and contained total Cl sufficient to form 0·1580 grm. NH_4Cl.

Sol. aluminum chloride, containing excess of HCl. 10 c.c gave 0·0225 grm. alumina, and contained total Cl sufficient to form 0·1839 grm. NH_4Cl.

Gooch's method of filtration was employed. Dimensions of perforated crucibles :—Height, 1 inch ; diameter at top, 1 inch ; diameter at bottom, ⅞ inch. Each perforated crucible was provided with a plain one to serve as a jacket ; the two with cover weighed 25 to 26 grms. All weighings and ignitions were made with the jacket on. The asbestos used was a fine picked sample obtained from Townson and Mercer. It was purified as usual by boiling in HCl solution, washed, dried, ignited over the blast to constant weight, and kept in distilled water. The same felting can be used repeatedly. In making a large number of estimates this is of considerable importance, for when the felting is new the filtrate is apt to be slightly turbid, requiring to be returned once or twice ; if the felting has been once used this does not occur. After removing the bulk of the precipitate, a soft dry cloth is used to rub the inside of the crucible ; the latter is then inverted and struck gently on the palm of the hand to remove loose particles. If the felting drops out, replace and mend it under suction, which does not take a minute. Particles still adhering firmly are of course included in the tare.

Except when otherwise stated, the experiments extending over more than a year were made at the temperature of the Laboratory, 25° to 32° C.

Experiments with the Solid Salt Method.

The quantity taken for each estimate was about 0·3766 grm. This should give 0·2 grm. magnesic pyrophosphate. Dissolved in 100 c.c. water. Added 12 c.c. Mg mix. No. 1, about 2 c.c. at a time, stirring well after each addition. When the precipitate had settled, added 10 c.c. No. 1 NH_3. Let rest about ten hours.* Filtered, using the mother-liquor to rinse the beaker, and a trimmed feather to clean it. Washed with 200 c.c. No. 3 NH_3. Ignited over Berzelius lamp fed with strong spirit ; when quite cold weighed ; no desiccator required.

February, 1883. *Series A.*

Made with the salt crushed and pressed December 10th, 1882.

	No. of Expt.	Weight of Salt in grms.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts. take.
A	1	0·3765	0·2000	0·2000	100·00
	2	0·3755	0·1994	0·1994	100·00
	3	0·3753	0·1993	0·1997	100·20
	4	0·3766	0·2000	0·2000	100·00
	5	0·3760	0·1997	0·1995	99·90
	6	0·3764	0·1999	0·1998	99·95
				Average ..	100·01

February, 1883. *Series B.*

Made with the salt crushed only December 24th, 1882.

B	7	0·3759	0·1996	0·1996	100·00
	8	0·3764	0·1999	0·2000	100·05
	9	0·3762	0·1998	0·2002	100·20
	10	0·3773	0·2004	0·2005	100.05
	11	0·3768	0·2001	0·2000	99·95
	12	0·3782	0·2009	0·2009	100·00
				Average ..	100·04

* Having started with these strengths, I kept to them. Every fresh bottle of strong ammonia opened was titrated with normal HCl and diluted to the above standards.

* This was unavoidable. I had to allow the same time before filtering in all the experiments. It has been repeatedly shown by others a much shorter time will suffice.

March, 1883. *Series C.*

Made with the salt crushed and pressed December 10th, 1882. In these experiments the Mg mixture was delivered from a burette, one drop a second, with constant stirring.

No. of Expt.	Weight of Salt in grms.	$Mg_2P_2O_7$ required	$Mg_2P_2O_7$ found	P_2O_5 found for 100 pts. takn.
C 13	0·3762	0·1998	0·1995	99 85
14	0·3763	0·1998	0·1998	100·00
15	0·3772	0·2003	0·2003	100·00
16	0·3767	0·2000	0·1998	99·90
17	0·3777	0·2006	0·2005	99·95
18	0·3768	0·2001	0·2000	99·95
			Average ..	99·94

Summary.

Series A .. 100·0
B .. 100·04
C .. 99·94 Average, 100 p. ct.

Remarks.—0·3766 grm. microcosmic salt requires 11 c.c. of Mg mix. No. 1 for exact precipitation of the P_2O_5; 12 c.c. therefore gives an excess of 9·09 per cent. The precipitates were nearly white, and previous experiments had shown that when ignited, as in these, to constant weight over the lamp, the loss when submitted to a powerful blast was very slight. The only means at my disposal for obtaining this were a large Russian lamp combined with a clay flue.

Several of the precipitates were placed together in a plain platinum crucible after ignition over the lamp, weighed, and submitted to the blast with the following results.—

	Weight of Precipitates taken, in grammes.	Loss in grammes.
1	0·8247	0·0007
2	0·7734	0·0007
3	0·7812	0·0006
4	0·7626	0·0008
5	0·9954	0·0008
	4·1373	0·0036

Taking the average, we should have to allow 0·09 per cent off the average of the eighteen experiments recorded above, making the result 99·91 instead of 100. For comparative purposes in studying the influence of various reagents, it will be necessary to make this correction unless the P_2O_5 is precipitated in the presence of a considerable quantity of ammonium citrate.

No allowance has been made for the solvent action of the dilute ammonia used to wash with. The exact amount of error this would give rise to can hardly be determined by work done with a salt containing water of crystallisation. This point will be referred to again further on.

In all the experiments that follow—except when otherwise stated—I used, as in the above, 200 c.c. No. 3 NH_3 to wash the precipitate. Repeated trials had shown this was amply sufficient.

Preparation of Solutions.

Making up a larger volume than 500 c.c. at a time was found not to answer for the reason already given. 7·5318 grms. of the salt were dissolved, made up to 500 c.c., and the solution weighed—weight 502·66 grms. 25 c.c. would weigh 25·133 grms, contain 0·3766 grm. microcosmic salt, and yield 0·2 grm. magnesic pyrophosphate. To avoid errors from inaccuracy in measuring and variations of temperature, the 25 c.c. taken for each estimate were weighed in the beaker covered with a small clock glass. To avoid the necessity of using a new factor for correction with every fresh solution made, the flask was not filled quite to the mark, and weighed; the water required to make up the weight to 502·66 grms. was weighed in a small beaker; the whole was then well mixed and transferred to accurately ground reagent bottles, to hold about 200 c.c. Commenced to use these solutions the day after they were made.

Test Experiments.

25 c.c. micro. solution diluted with 75 c.c. water, and precipitated with 12 c.c. Mg mix. No. 1. 10 c.c. No. 1 NH_3 added after the precipitate had settled. Washed with 200 c.c. No. 3 NH_3, and ignited over the Berzelius lamp. I shall call these test experiments. As regards the manner of adding the Mg mixture, after seeing Gladding's recommendation to deliver from a burette one drop a second with constant stirring, I always adopted this method, but as my results are not recorded in the order in which they were obtained, it will be necessary to state when the reagent was delivered from the measure (about 2 c.c. at a time, the method first adopted), and when from the burette. The tests were sometimes modified by adding the 10 c.c. No. 1 NH_3 before precipitation instead of after. This was done to make the condition as regards the ammonia the same as in the precipitation of P_2O_5 in presence of ammonium oxalate and citrate, for if ammonia in considerable quantity is not added in these cases before precipitation, the precipitate has a tendency to adhere strongly to the glass.*

Except in the case of a few experiments made on the influence of heat, the rule has generally been to make a test experiment with two others on the influence of reagents. In four series I have made two tests with one other experiment for the purpose of comparing the average results of series consisting of six experiments, each made under exactly similar conditions. The conclusion arrived at from these experiments and others is that the difference between average results so obtained will never amount to 0·1 per cent, and seldom to as much as 0·05 per cent.†

By the method adopted in working with solutions, the value of the results for purposes of comparison would not be impaired by slight inaccuracy in preparing the solution, nor by slight alteration in its strength during use, nor by slight loss of water of crystallisation in the salt.

However, considering the great care taken in preparing and preserving the solutions, and that the 500 c.c. were consumed in a week, loss of water of crystallisation is really the only point that requires consideration. However carefully preserved, the salt will lose a little during a long course of experiments made with it, and the loss will not be uniform throughout the mass.

I have studied:—

1. The influence of heat.
2. Effect of precipitating with excess of Mg mixture added gradually, and added all at once to solutions diluted as usual.
3. Effect of precipitating with excess of Mg mix. added all at once to a concentrated solution of micro. salt, and the effect of adding the reagent one drop a second contrasted with adding it 2 c.c. at a time to solutions diluted as usual.
4. Effect of precipitating with slight excess of Mg mix. added gradually to a concentrated solution of micro. salt, and the precipitation of P_2O_5 in presence of ammonium chloride in solutions diluted as usual.
5. The solvent action of NH_4Cl on the precipitate, and the effect of Mg mix. in counteracting this.
6. Effect of precipitating with *neutral* Mg mix. in solutions of micro. salt diluted as usual.
7. The effect of precipitating with slight excess of *neutral* Mg mix. added gradually to concentrated solution of micro. salt, and the precipitation of P_2O_5 in presence of ammonium sulphate with slight and larger excess of reagent.
8. Influence of ammonia.
9. Solvent action of No. 2 NH_3 on the precipitate, and of No. 3 NH_3.

* Yet there are reasons why this modification of the *test* is not advisable, and after a time I abandoned it.

† Except perhaps where the P_2O_5 is precipitated in presence of considerable quantities of ammonium citrate or oxalate.

10. Precipitation of P_2O_5 in presence of ammonium oxalate with slight and large excess of Mg mix., and precipitating in presence of ammonium oxalate and NH_4Cl with slight excess of reagent.
11. Solvent action of ammonium oxalate on the precipitate, and influence of Mg mix. in counteracting this.
12. Precipitation of P_2O_5 in presence of ammonium citrate with slight and large excess of Mg mix., and precipitating in presence of ammonium citrate, oxalate, and chloride with excess of reagent.
13. Solvent action of ammonium citrate on the precipitate, and the influence of Mg mix. in counteracting this.
14. Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, and chloride, ferric oxide, and alumina, with large excess of Mg mix.
15. Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, sulphate, and chloride; ferric oxide and alumina, with large excess of Mg mix.

The Influence of Heat.

In this instance eight test experiments were made first, and eight soon after on the influence of heat, with the same solution.

November, 1882. Series D.—Eight tests. Solution made with salt crushed and pressed in the same month. Mg mixture from measure.

Tests.

No. of Expt.	Weight of Sol. in Grammes.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts.tkn.
D 19	25·150	0·2001	0·2002	100·05
20	25·168	0·2003	0·2004	100·05
21	25·145	0·2001	0·2003	100·10
22	25·132	0·2000	0·2003	100·15
23	25·146	0·2001	0·2001	100·00
24	25·149	0·2001	0·2001	100·00
25	25·135	0·2000	0·2002	100·10
26	25·159	0·2002	0·2005	100·15
			Average ..	100·07

November, 1882. Series E.—Solution was heated to 80° to 90° C., the flame of the lamp made small and placed about 4 inches from the bottom of the beaker. Precipitated Mg mix. from measure; in other respects conditions as in the tests. Temperature at end of precipitation about 60° C.

In the Heat.

No. of Expt.	Weight of Sol. in Grammes.	$Mg_2P_2O_7$ required.	$Mg_2P_2O_7$ found.	P_2O_5 found for 100 pts.tkn.
E 27	25·136	0·2000	0·1998	99·90
28	25·136	0·2000	0·2000	100·00
29	25·146	0·2001	0·2000	99·95
30	25·135	0·2000	0·2000	100·00
31	25·128	0·2000	0·2001	100·05
32	25·137	0 2000	0·2001	100·05
33	25·135	0·2000	0·2002	100·10
34	25·137	0·2000	0·2007	100·35
			Average ..	100·05

In future each series will consist of eighteen experiments, including tests. Three estimates were made per day, and the rule observed was to take the quantity required for the three from the same bottle. To save space, the weights of solutions and precipitates will not be given, but only the P_2O_5 obtained for 100 parts taken. The experiments were made in the order in which the results are recorded in the tables, reading horizontally. Thus, Experiments Nos. 35, 41, 47 were made together; No. 36, 42, 48 made together; and so on.

Effect of precipitating with excess of Mg. Mixture added gradually and added all at once to solutions diluted as usual.

February, 1883. Series F.—Solution from the salt crushed and pressed, November, 1882.

Six Experiments.—In each, precipitated with 33 c.c. Mg Mix. No. 1, 2 c.c. at a time from the measure. All other conditions the same as tests.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1, added all at once. All other conditions the same as tests.

Six Tests.—Mg mixture from measure.

No. of Expt.	33 c.c. Mg Mix. No. 1 added gradually.	No. of Expt.	15 c.c. Mg Mix. No. 1 added all at once.	No. of Expt.	Tests.
F 35	100·00	F 41	100·35	F 47	100·05
36	100·15	42	100·70	48	100·10
37	100·15	43	100·15	49	100·15
38	100·15	44	100·30	50	99·95
39	100·20	45	100·30	51	100·15
40	100·25	46	100·40	52	100·20
Average	100·15	Average	100·37	Average	100·10

Effect of precipitating with excess of Mg Mixture added all at once to a concentrated solution of Micro. Salt, and the effect of adding the reagent one drop a second contrasted with adding it 2 c.c. at a time to solutions diluted as usual.

February, 1883, Series G.—Solution from the salt crushed and pressed December 10, 1882.

Six Experiments. In each, added to 25 c.c. micro. solution (without further dilution) 20 c.c. Mg Mix. No. 1 all at once. When the precipitate had settled, added 10 c.c. No, 1 NH_3.

Six Experiments. In each, precipitated with 12 c.c. Mg Mix. No. 1, delivered from burette one drop a second. All other conditions same as tests.

Six Tests.—Mg Mixture from measure.

No. of Expt.	20 c.c. Mg Mix. to concentrated sol. all at once.	No. of Expt.	12 c.c. Mg Mix. added one drop a second.	No. of Expt.	Tests.
G 53	100·30	G 59	99·90	G 65	100·10
54	100·20	60	99 95	66	100·10
55	100·25	61	99·90	67	100·10
56	100·25	62	100·00	68	99·95
57	100·30	63	100·00	69	99·95
58	100·30	64	100·00	70	100·05
Average	100·27	Average	99·96	Average	100·04

Effect of precipitating with slight excess of Mg Mix. added gradually to a concentrated solution of Micro. Salt, and the precipitation of P_2O_5 in presence of ammonium chloride in solutions diluted as usual.

March, 1883. Series H.—Solution from the salt crushed and pressed December 10, 1882.

Six Experiments.—In each, added to 25 c.c. micro. solution (without further dilution), 12 c.c. Mg Mix. No. 1 from burette. When precipitate had settled added 10 c.c. No. 1 NH_3.

Six Experiments.—In each, precipitated in presence of 2 grammes NH_4Cl. Mg Mix. from burette; all other conditions same as tests.

Six Tests.—Mg Mixture from burette.

No. of Expt.	12 c.c. Mg Mix., a drop a second to concen. sol.	No. of Expt.	2 grms. NH_4Cl. 12 c.c. Mg Mix.	No. of Expt.	Tests.
H 71	99·90	H 77	99·75	H 83	99·95
72	99·75	78	99·90	84	100·15
73	99·85	79	99·95	85	100·20
74	99·75	80	99·95	86	100·10
75	100·00	81	100·00	87	100·20
76	99·90	82	100·05	88	100·15
Average	99·86	Average	99·93	Average	100·12

March, 1883. Series I.—Crushed and pressed a fresh portion of the salt, and repeated experiments as in series H.

I	89	99·70	I	95	99·80	I	101	100·05
	90	99·75		96	99·85		102	100·05
	91	99·80		97	99·80		103	100·00
	92	99·95		98	99·90		104	99·90
	93	99·85		99	99·85		105	99·95
	94	99·80		100	99·85		106	99·95
Average		99·81	Average		99·84	Average		99·98

The solvent action of NH_4Cl on the precipitate, and the effect of Mg Mixture in counteracting this.

July, 1883. Series J.—Solution from the salt bruised and mixed, April, 1883, Mg Mix. from burette.

Six Experiments.—In each, washed the precipitate, first with 50 c.c. No. 3 NH_3, then with 110 c.c. of a solution composed of 100 c.c. water, 10 c.c. No. 1 NH_3 and 6 grammes NH_4Cl. Finally, washed with 150 c.c. No. 3 NH_3. All other conditions same as tests.

Six Experiments.—In each, proceeded as above, except that to the solution containing 6 grammes NH_4Cl I added 20 c.c. Mg Mixture No. 2.

Six tests.

No. of Expt.	Washed with sol. containing 6 grammes NH_4Cl.	No. of Expt.	Washed with sol. containing 6 grammes NH_4Cl and 20 c.c. Mg Mix. No. 2.	No. of Expt.	Tests.
J 107	98·35	J 113	100·00	J 119	100·00
108	98·40	114	100·05	120	100·05
109	98·55	115	100·00	121	100·10
110	98·75	116	100·20	122	100·10
111	98·80	117	100·00	123	100·05
112	98·90	118	100·25	124	100·05
Average	98·62	Average	100·08	Average	100·06

Effect of precipitating with neutral *Mg Mix. in solution of Micro. Salt diluted as usual.*

April, 1883. Series K.—Solution from the salt in its original condition. Mg Mixture from burette.

Six Experiments.—In each, precipitated with 12 c.c. *neutral* Mg Mixture; added 10 c.c. No. 3 NH_3 very gradually. All other conditions same as tests.

Twelve tests.

No. of Expt.	Neutral Mg Mix. 12 c.c.	No. of Expt.	Tests.	No. of Expt.	Tests.
K 125	99·85	K 131	99·85	K 137	99·95
126	100·05	132	100·00	138	100·00
127	100·00	133	100·00	139	100·10
128	100·05	134	100·10	140	100·05
129	100·05	135	100·00	141	99·95
130	100·05	136	100·00	142	100·05
Average	100·01	Average	99·99	Average	100·02

The effect of precipitating with slight excess of neutral *Mg Mix. added gradually to concentrated solution of Micro. Salt, and the precipitation of P_2O_5 in presence of ammonium sulphate with slight and larger excess of reagent.*

May, 1883. Series L.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to 25 c.c. micro. solution (without further dilution) 12 c.c. neutral Mg mix. Then (also from burette) 10 c.c. No. 3 NH_3, one drop a second with constant stirring. When the precipitate had settled, added 5 c.c. No. 1 NH_3.

Six Experiments.—In each, precipitated with 24 c.c. Mg Mix. No. 1 in presence of 0·5 grm. ammonium sulphate. All other conditions same as tests.

Six Tests.

No. of Expt.	Precipitated with 12 c.c. neutral Mg Mix. in concentrated solution.	No. of Expt.	0·5 grm. NH_4O,SO_3. 24 c.c. Mg Mixture.	No. of Expt.	Tests.
L 143	100·05	L 149	100·10	L 155	99·95
144	99·95	150	100·25	156	100·00
145	99·95	151	100·35	157	99·95
146	100·05	152	100·30	158	99·90
147	99·95	153	100·15	159	99·95
148	100·15	154	100·45	160	100·10
Average	100·02	Average	100·27	Average	99·98

June, 1883.—Series M.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1 in presence of 0·5 grm. ammonium sulphate. All other conditions same as tests.

Six Experiments.—In each, precipitated with 15 c.c. Mg Mix. No. 1 in presence of 0·25 grm. ammonium sulphate. All other conditions same as tests.

Six Tests.

No. of Expt.	0·5 grm. NH_4O,SO_3. 15 c.c. Mg Mix.	No. of Expt.	0·25 grm. NH_4O,SO_3. 15 c.c. Mg Mix.	No. of Expt.	Tests.
M 161	99·90	M 167	99·95	M 173	99·90
162	100·20	168	100·10	174	100·05
163	100·10	169	100·05	175	99·95
164	100·05	170	99·90	176	99·90
165	100·05	171	100·00	177	99·90
166	100·10	172	100·15	178	100·00
Average	100·07	Average	100·02	Average	99·95

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

BORON.

THE atomic weight of this element has been determined by Berzelius and by Laurent, and calculated by Dumas from some experiments by Deville.

Berzelius† based his determination upon three concordant estimations of the percentage of water in borax. Laurent‡ made use of two similar estimations, and all five may be properly put in one series, thus :—

47·10 } Berzelius.
47·10 }
47·10 }
47·15 } Laurent.
47·20 }

Mean 47·13 ± 0·013

Hence B = 10·943 ± 0·023.

Dumas'|| calculations were based on Deville's analyses of the chloride and bromide of boron, which give the ratios between AgCl and BCl_3, and between AgBr and BBr_3. Reducing the weighings to a common standard, 100 parts of silver chloride correspond to the quantities of boron trichloride given in the third column :—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Poggend. Annal.*, 8, 1. 1826.

‡ *Journ. f. Prakt. Chem.*, 47, 415. 1849.

|| *Ann. Chem. Pharm.*, 113, 31. 1860.

0·6763 grm. BCl_3 = 2·447 grms. AgCl. 27·303
0·923 „ 3·395 „ 27·187

Mean 27·245 ± 0·039

Hence B = 10·808 ± 0·174.

With the bromide, 2·446 BBr_3 gave 5·496 AgBr. If we assign this experiment equal weight with one in the chloride series, and include the probable error of Br, B = 10·964 ± 0·364.

The three values combine as follows:—

From borax	B = 10·943	± 0·023
From BCl_3	„ = 10·808	0·174
From BBr_3	„ = 10·964	0·364
General mean ..	„ = 10·941	± 0 023

If O = 16, B = 10·966.

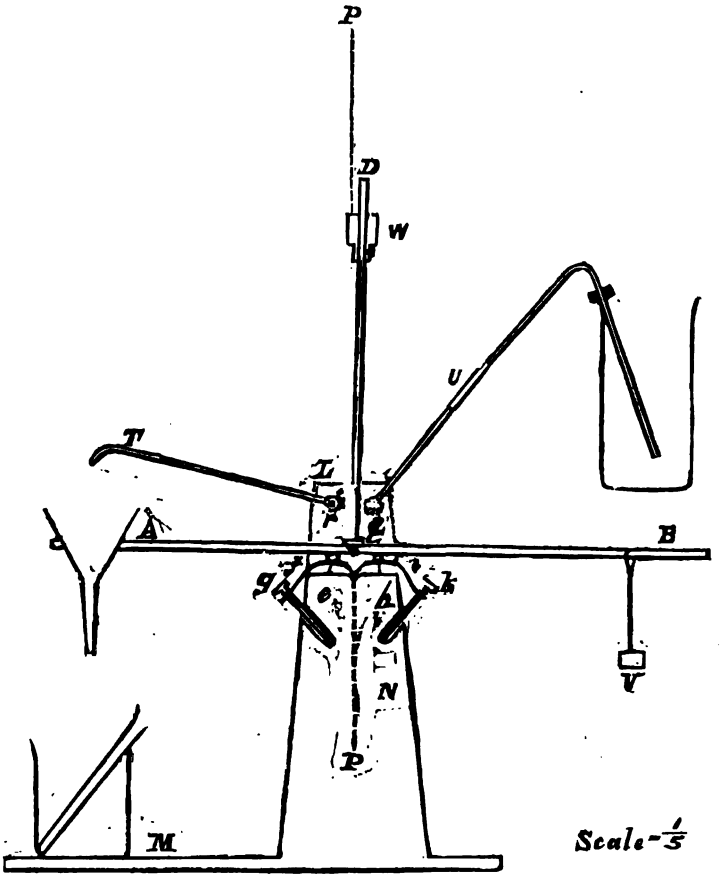
Further investigation of the atomic weight of boron is evidently desirable.

New Method of Insulating Metallic Wires employed in Telegraphy and Telephony.—C. Wiedemann.—The author prepares a bath of potassium plumbate by dissolving 10 grms. of litharge in a litre of water to which 200 grms. caustic potassa have been added. The whole is boiled for half an hour, let settle, and decanted, when the clear liquid is ready for use. The wire to be coated is attached to the positive wire, and a small anode of platinum is plunged into the bath at the negative pole. The insulation of the wire is complete when it has taken a black-brown colour.—*Comptes Rendus.*

FILTRATION BALANCE.

By F. P. DUNNINGTON.

ALL the arrangements for the automatic washing of precipitates, of which I have seen previous mention, provide for keeping the water at nearly a constant level in the funnel. By this method of washing a precipitate, usually much more water is necessary than if each portion is allowed to drain off before a new addition of it. At the Cincinnati meeting of the American Association for the Advancement of Science in 1881, Prof. H. Carmichael, of Bowdoin College, Maine, exhibited a filtration and evaporation balance, which I must describe before giving my modification of it. The figure without the upright CD, illustrates this balance, which is most convenient for delivering a large amount of liquid on a small filter or into a small evaporating dish.



A beam, AB, balanced on the knife-edge (or pivot), C, supports in in a ring, A, the funnel which is equipoised by the weight, V. *s* and *r* are corks passed through the upright, NL, and hold in any position the tubes U and T, which are bent to pass through them. Close to C, and under the beam, passes a rubber tube, *e*, which connects tho tubes U and T, and conducts the wash-water or other liquid. By use of thumbscrews *g* and *k* the little brass arms *f* and *i* may be raised to adjust the pressure upou the rubber tubes *e* and *h*.

To the above-described apparatus I add a vertical rod, CD, fastened to the arm AB and at right angles to it; on th's is supported a weight, W, whose height is fixed by the

binding screw also sliding on this rod. I employ for two-inch funnels a cylindrical lead weight, V, weighing about 300 grms.; for three-inch funnels about 500 grms. The apparatus is used as follows:—

Having brought all the precipitate on the paper in a funnel, allow it to drain, put the funnel in place and fix the weight W near D, then slide the weight V on B until it will just be able to raise A from its lowest position, when of course W will move to the right of the vertical PP. Then water will pass through *e* and drop into the funnel until it is nearly full, when (if W and *k* are adjusted properly), A will fall, bringing W to the left of the vertical, and in this position no water will pass through *e*. When the funnel has again drained, the arm A rises, and (the water again flows into the funnel) this alternating motion continues so long as water is supplied. I have made AB of iron 10×4 m.m. The upright NL is 35 m.m. thick; other dimensions may be taken from the figure. It is essential that the tube *e* admits of being closed by very gentle pressure (less than 100 grms.) of the knife-edge cut on the under side of the beam. I use for this pure rubber tubing 2·5 m.m. exterior diameter.

Removing W the apparatus may be used as was intended by Prof. Carmichael. When conducting an evaporation, the dish rests in A, and the gas passes through *h* to the burner, so that when the liquid is exhausted, and before that in the dish has come to dryness, the arm A will rise, compress *h*, and so extinguish the flame.—*Amer. Chem. Journ.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 1, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—C. J. Baker, F. A. Blair, L. Briant, R. Datta, R. G. Durrant, T. Hart, A. E. Harris, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. H. Rogers, N. G. Whittam, H. A. Wetzel.

The PRESIDENT announced that no books would be issued from the Library during the present month, in consequence of the preparation of the Catalogue; the books can be used for reference as usual.

The SECRETARY read the following papers:

"*On the Production of Hydroxylamine from Nitric Acid*," by E. DIVERS. Lossen, in 1865, prepared this substance by the action of tin and hydrochloric acid on ethyl-nitrate. Maumené showed that ammonium nitrate might be substituted for ethyl-nitrate. In 1872, the author found that sodium nitrate, and indeed nitric acid itself, could be used with excellent results. Since then the author has worked at the subject, and his results are given in the present paper. The author gives a detailed account of the action of various metals on nitric acid alone, and in the presence of hydrochloric or sulphuric acid. As an example, 58 c.c. of fuming hydrochloric acid were mixed with 5 c.c. of nitric acid (sp. gr. 1·42), and the mixture poured quickly on 35 grms. of granulated tin, placed in a flask filled with carbon dioxide. The flask was cooled by immersion in water; the ebullition soon ceased, and the solution was then poured off: 21 grms. of tin were dissolved. The solution was diluted, the tin removed by sulphuretted hydrogen, &c., and the hydroxylamine in the filtrate determined by decinormal solution of iodine, sodium carbonate being added to keep the solution alkaline. About 4½ grms. of nitric acid were thus converted (out of 5 grms.) into hydroxylamine. The following is suggested as a good lecture experiment to show the formation of hydroxylamine. Pour some dilute sulphuric acid on zinc, and then add a little nitric acid; in half a minute pour off the acid solution, add a large excess of potassium hydrate so as to dissolve the zinc hydrate, and then a very little copper sulphate solution. The characteristic yellow precipitate, proving the presence of hydroxylamine, will appear on stirring. The latter part of the paper contains a rather lengthy discussion on the nature of the reduction of nitric acid. The author gives the following summary of his results:—Free nitric acid yields hydroxylamine when treated with tin, zinc, cadmium, magnesium, and aluminium. In the presence of hydrochloric or sulphuric acid the quantity (with tin and zinc) may be considerable. Without a second acid only traces of hydroxylamine can be detected. There is no reason to believe that the action of the hydrochloric or sulphuric acid upon the metal is instrumental in forming hydroxylamine. The second acid serves to decompose nitrate as fast as it is produced. In this way (1) it holds the hydroxylamine in a state more stable that the nitrate; (2) it preserves the hydroxylamine from the destructive action of nitrous acid by preventing that formation of this acid which would otherwise result from the reaction between a metal yielding hydroxylamine and its own nitrate; and (3) it determines the reduction of all the nitric acid to hydroxylamine by supplying the hydrogen for reproducing it and so keeping it free to the last. Metals act upon nitric acid in one of two ways, and are accordingly divisible into two classes. One includes the metals, silver, mercury, copper, and bismuth, which form nitrite, water, and nitrate, but neither ammonia nor hydroxylamine, and do not convert their nitrate to nitrite. These metals decompose nitric acid into hydroxyl and nitroxyl, combining with these radicals to form hydroxide and nitrite, which by secondary reactions become water, nitrous acid, and metal nitrate. These metals, therefore, separate nitrogen from oxygen (hydroxyl) in decomposing nitric acid; they do not in this decomposition separate hydrogen from oxygen, just as they do not do so in any other case. The other class of metals includes tin, zinc, cadmium, magnesium, aluminium, lead, iron, and the alkali metals. These metals form ammonia and generally also hydroxylamine; they do not yield nitrite or nitrous acid with free nitric acid, but they readily form nitrite by acting on their own nitrate. They exercise two actions—one upon the nitric acid, the other upon the hydroxylamine. They act first upon seven molecules of the acid, separating, in the form of hydroxylamine, the hydrogen of six of them by forming nitrate, and leaving the seventh converted into water and hydroxylamine. This action occurs without evident break into successive stages. The second action of these metals is that in which they combine with hydroxylamine to form metal ammonium hydroxide, which decomposes with water into metal hydroxide and ammonia. Nitrites have a constitution indicated by the name nitronates, *i.e.*, they have their metal directly united to their nitrogen. They have the same radical, NO_2, as nitrates have, these being its metal-oxyl compounds.

Prof. DEBUS, while recognising the great value of the paper as to its experimental work, could not agree with some of the theoretical conclusions. The statement that a metal attached itself directly to nitrogen in a nitrite seemed quite hypothetical.

Dr. ARMSTRONG said there was so much to be learned as to the action of nitric acid, that we were as yet hardly in a position to discuss its decompositions. There seemed to be very little doubt that pure nitric acid had no action upon silver, but that some nitrous acid was necessary to start the reaction.

"*On the Chemistry of Lacquer* (*Part I.*), a communication from the Chemical Society of Tokio, by H. YOSHIDA. Japanese Lacquer (Urushi) is the milky secretion of *Rhus vernicifera*. The tree is 9 to 12 ft. high, and resembles the ordinary waxtree. Two varieties of Urushi exist, "Ki urushi" and "Seshime urushi." The "Ki urushi,"

or raw lacquer, is the best, being the natural juice, which exudes from cuts in the stem; the "Seshime urushi" being prepared by soaking branches and twigs for some months in water. The urushi is usually coloured with lampblack, vermilion, indigo, &c. The pure urushi is a thick greyish fluid, having a characteristic sweetish odour; sp. gr. 1·0020° at 20° C. When exposed to moist air at 20° in thin layers, it rapidly darkens in colour, and dries up to a lustrous translucent varnish. Ishimatsu, on February 18, 1879, gave some account of this lacquer to the Manchester Philosophical Society, and showed that it contained a resin, a gum, water, and a small quantity of residue insoluble in ether, water, and alcohol. The author extracted urushi with alcohol, and obtained a peculiar acid, urushic acid, and a volatile poisonous substance. Urushic acid, $C_{14}H_{18}O_2$, is a pasty substance, soluble in benzene, &c., which does not dry up when exposed to moist air. The author has studied the action of bromine, strong hydrochloric acid, and nitric acid, and has prepared the copper, lead, and iron salts. The gum is identical with gum arabic. A mixture of gum and urushic acid does not harden on exposure to the air. The portion insoluble in alcohol and boiling water contains a peculiar nitrogenous substance, but it has, after boiling, no action on urushic acid. If, however, after extracting the urushi with alcohol, the residue be treated with cold water, an extract is obtained containing a diastatic matter, which effects the hardening of urushi. The author has made experiments as to the hardening of urushi in different gases. He finds that moist air and a temperature of 20° to 23° C. are the most favourable conditions. After the hardening, the urushic acid is found to be converted into a new substance, oxy-urushic acid, $C_{14}H_{18}O_3$, quite insoluble in every substance tried. This body can be formed by the action of strong chromic acid on urushic acid.

The President said that the mode of action of the diastase did not seem very fully explained in the paper. It was curious that the lacquer varnish dried best in moist air, the reverse being the case with the ordinary varnishes in use in this country. In some experiments which he had made with an amber varnish he had found that sunlight had a great influence in promoting the hardening of the varnish.

"*On some Compounds of Phenols with Amido-bases*," by G. Dyson. In a recent paper Dale and Schorlemmer came to the conclusion that aurin combines with the amido-bases, and prepared pure rosanilin phenate. The author has prepared and investigated this and several other similar compounds—aniline phenate, toluidine phenate, naphthylamine phenate, aniline-β-naphthate, toluidine naphthate, rosaniline phenate, xylidine naphthate, rosaniline aurinate, aniline aurinate.

"*On the Alleged Decomposition of Phosphorous Anhydride by Sunlight*," by R. Cowper and V. B. Lewes. In a paper read before the Southport Meeting of the British Association by the Rev. A. Irving the author states that phosphorous anhydride, prepared by passing a slow stream of dry air over molten phosphorus, decomposes when exposed to sunlight into amorphous phosphorus and phosphoric anhydride. The authors have repeated this experiment and analysed the sublimate obtained in the manner described by Irving. It consisted of 78·2 per cent of phosphoric anhydride, 4·7 per cent phosphorous anhydride, and 17 per cent of phosphorus. On exposing this white mixture to sunlight it became red, the phosphorus being converted into the amorphous variety. In another experiment the air, after passing over the melted phosphorus, bubbled through carbon disulphide. After some time the bisulphide was allowed to evaporate on blotting-paper, when enough phosphorus was left behind to give dense fumes.

Prof. Debus called attention to the fact that it was generally stated in text-books that phosphorous anhydride could be prepared by passing air over heated phosphorus.

The Society then adjourned to November 15.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, Nov. 5, 1883.

Sir William Siemens, D.C.L., LL.D., F.R.S., Manager and Vice-President, in the Chair.

John Coles and Ludwig Mond, F.C.S., were elected Members of the Royal Institution.

Five Candidates for Membership were proposed for election.

William Miller Ord, M.D., was elected a Manager in the room of the late Mr. William Spottiswoode, P.R.S.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 3rd, 1883.

H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

The President exhibited the ash of burnt diamonds, and enlarged drawings of the same.

"*On the Occurrence of Caffeine in the Leaves of Tea and Coffee grown at Kew Gardens*," by C. Schorlemmer, F.R.S.

Some time ago I wanted some information on the plants containing caffeine. This interesting compound is not only found in the seeds of *Coffea arabica*, but also in the fleshy part of the berry and in the leaves. The latter are used in Sumatra by the natives in the place of tea, and some years ago a patent was taken out for the introduction of "Coffee-tea" into this country, but it has not been successful.

Caffeine also occurs in the leaves of different species or varieties of tea; in Paraguay-tea, consisting of the leaves and small twigs of *Ilex paraguayensis*; and in Guarana or Brazilian chocolate, which is obtained from the roasted seeds of *Paullinia sorbilis*. It has further been found in Cola-nuts, the seeds of *Sterculia acuminata*, which are extensively used as a condiment by the natives of western and central tropical Africa; and likewise by the negroes in the West Indies and Brazil, by whom the tree has been introduced in these countries. It is said that they promote digestion, improve the flavour of anything eaten after them, to counteract the effects of alcohol, and even to render half putrid water drinkable. Cola-nuts contain also theobromine, which is a very interesting fact, inasmuch as this base, which was first found in *Theobroma Cacao*, belonging also to the *Sterculiaceæ*, can be easily transformed into caffeine.

In collecting this information I consulted, amongst other works, "the Treasure of Botany," edited by Lindley and Moore, where I found the statement that the custom of drinking coffee originated with the Abyssinians, who cultivated the plant from time immemorial. In Arabia it was not introduced until the early part of the fifteenth century; before this time the beverage made from the leaves of the kât (*Catha edulis*) was generally used, and is still in use, possessing properties resembling those of strong green tea, only more pleasing and agreeable. The leaves are also chewed, and are said to have the effect of producing great hilarity of spirits, and such an agreeable state of wakefulness that the Arabs who chew them are able to stand sentry all night long without feeling drowsy.

As the properties of kât resemble so much those of tea, it appeared to me highly probable that they contain caffeine. My friend, Mr. H. Marshall Ward, was kind enough to apply to Professor W. T. Thistleton Dyer, F.R.S., who supplied me in the beginning of December with fresh leaves of a plant growing in the

temperate house at Kew Gardens. He also sent me a sample from the museum. He says:— "The material in our museum is not very satisfactory, but I enclose a portion of an authentic sample. The leaves are different in form from those of the living plant, but I have ascertained that in this respect they are variable."

I first examined the fresh leaves; not a trace of caffeine could be found, while its presence can be easily shown in three or four tea-leaves. The only crystalline compound which I could extract from Catha was a kind of sugar, apparently mannite. The quantity was, however, too small for identifying it.

No caffeine could be detected in the authentic sample, but it contained common salt, showing that it must have been in contact with sea-water.

As I fully expected to find caffeine and was disappointed, it occurred to me that possibly the leaves of tea and coffee grown at Kew might also not contain their characteristic principle.

Professor Dyer kindly supplied me with the fresh leaves of several varieties and species in the middle of February.

I found caffeine in green tea (*Thea viridis*) and in Assam tea (*T. assamica*).

The leaves of *Coffea arabica*, which is now fruiting in the gardens, contain it also, but much less in proportion than tea.

In *Coffea laurina* I found a trace, but none at all in the large old leaves of Liberian coffee.

Caffeine and theobromine occur only in the vegetable kingdom. They are nearly related to uric acid, guanine, and xanthine, which are products of the material exchanges of the animal organism. The two former can be converted into xanthine, and this, as Professor E. Fischer has shown, into theobromine or methylxanthine, and into caffeine or dimethylxanthine.

As caffeine is used in medicine, it appears very probable that in no distant time it will be manufactured from Peruvian guano, which is the best source for guanine.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 16, October 15, 1883.

Report on a Memoir by M. Raoult entitled—"General Law of the Solidification of Solvents."—The principal conclusions of M. Raoult's investigation are:—Every body, solid, liquid, or gaseous, when dissolving in a definite liquid compound capable of solidification, lowers its point of congelation. Of two specimens of any body the purest is that which solidifies or melts at the highest temperature. The atomic, or molecular, lowering is sensibly constant for each solvent. For most organic compounds soluble in acetic acid without alteration, it varies from 36 to 41, the mean being 39. For formic acid the mean lowering is 29; for benzol, 50; for nitro-benzol, 73; and for ethylene bibromide, 119. M. Raoult proposes the following general law:—If we search for the atomic lowering produced, not in one and the same weight of the solvent, but in weights of each solvent proportional to its atomic weight, equal, *e.g.*, to 100 times the atomic weight of the various liquids, we find that the lowering of the congelation is independent of the nature of the dissolved body and of the solvent.

A Means of Insulating the Thermic Radiations from the Luminous and Chemical Radiations.—F. van Assche.—Upon a slip of glass, the *port-object*, is deposited a drop of distilled and melted selenium, which is immediately covered with a slip of thin glass. The drop is then compressed by means of a needle, keeping the slip upon a metallic plate at 250°, so as to spread out the selenium in a very thin homogeneous layer. Finally the arrangement is let cool very slowly under pressure. The selenium must not be allowed to boil upon the plate. By this stratum the chemical rays are reflected, the luminous vibrations are converted into electric energy, whilst the thermic waves alone traverse the plate after having undergone a certain refraction, which is rotatory if the plate turns in its own plane, but fixed if the apparatus is immovable.

Refraction Indices of Fluor Spar for Rays of Different Wave-lengths up to the Extreme Ultra-Violet.—Ed. Sarrasin.—The author's results are given in a table, which space does not allow us to reproduce.

Determination of the Equivalents of Metals by Means of their Sulphates.—H. Baubigny.—This paper will be inserted in full.

Occlusion of Glucose by a Plumbic Precipitate.—P. Lagrange.—To determine exactly the glucose in a cane-sugar the method of precipitation with basic lead acetate must be abandoned.

The Guano of Cape Verd.—This guano contains merely 0·28 per cent of organic nitrogen, 0·04 ammoniacal nitrogen, and 11·37 of phosphoric acid. On the other hand, the percentage of silica and silicates is 41·06.

Bulletin de la Société Chimique de Paris.
Nos. 6 and 7, October 5, 1883.

Combustion-heat of certain Coals and their Use for heating Steam-boilers,—M. Scheurer-Kestner.—A reply to the objections raised by M. Bunte and M. Stohmann against the former results of the author and of M. Dollfus.

Formation-heat of Potassium Fluorides.—M. Guntz.—The formation-heats of the anhydrous fluoride are respectively 30·98 and 38·22 cals., according as we set out from the liquid or the gaseous acid. The formation-heat of the hydrated fluoride, setting out from the gaseous acid = 41·45 cals. That of the hydrofluoride of potassium fluoride = 53·13 cals.

Preparation of Mesitylene.—Eugene Varenne.—The author mixes 180 grms. acetone with 300 grms. sulphuric acid, leaving them in contact for an hour. He then distils over a Bunsen burner with the flame very low. The Bunsen should have a very large rose so that all the lower part of the flask may be heated uniformly. Towards the end, when the mass is on the point of swelling up, a jet of steam is allowed to bubble through it, lowering the flame or extinguishing it entirely. The steam is passed through until striæ of mesitylene cease being formed on the sides of the refrigerating tube.

Determination of Total Nitrogen in Manures.—E. Dreyfus.—The author remarks that a manure may contain nitrogen in the organic form, soluble or insoluble, as ammonia, and in the nitric form. He criticises the method of Ruffle, which he finds inaccurate, and proposes the following process:—The manure is intimately mixed, and a portion weighing 1 grm. is taken, and placed in a small glass capsule, adding pure sulphuric acid of full strength, so as to saturate the manure, and heating the whole over a Bunsen burner. The sulphuric acid expels the nitric acid and dissolves the organic matter. When the solution is complete and the sulphuric acid begins to give off vapours, the heat is withdrawn. By this operation the manure is freed from every trace of nitric nitrogen, and there remain merely the totality of the organic nitrogen and of the ammoniacal nitrogen. When the capsule is cold finely-ground calcium carbonate is added until the resulting grey mass is absolutely dry and pulverulent. The whole is carefully detached from the glass and mixed with soda-lime for the determination of the organic and the ammoniacal nitrogen. The nitric nitrogen is then

determined in a second portion by Schlœsing's method. For preparing soda-lime, the author dissolves 1¼ parts caustic soda in 3 parts of water, and adds the solution to 3 parts of quicklime. To destroy any nitrates present as impurity in the soda M. Delarge dissolves a quantity of pure sugar in the soda-lye used for slacking the lime.

Anderson's Reaction.—Œchsner de Coninck.—Anderson's reaction is characteristic of the pyridic bases; it differentiates the pyridic from the quinoleic chloroplatinates; it establishes a clear distinction between the bases of the two pyridic and quinoleic series and their hydrides, and furnishes valuable indications in the study of the isomerism of these bases and of their derivatives.

Reaction of the Pyridic Bases with the Alcoholic Iodides.—Œchsner de Coninck.—This paper is not adapted for abstraction.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 9.

The Radiation of the Earth.—J. Tyndall.—From *Nature*.

Presence of Nitric Acid of Ammonia in the Water and Snow of the Alpine Glaciers.—M. Boussingault.—From the *Comptes Rendus*.

Micro-organisms in the Soil.—R. Koch and P. Miquel.—Both observers found the superficial layers of the soil exceedingly rich in bacilli. Miquel considers that these bacilli play an important part in the decomposition of organic matter and in the formation of assimilable plant food.

Aves-Guano.—Prof. Mærcker and Prof. Heiden.—This guano, obtained from certain small islands on the coast of Venezuela, contains 33 per cent of phosphoric acid, but only 0·21 nitrogen. It contains very little iron and alumina, and is, therefore, well adapted for the manufacture of superphosphate.

The Value of Various Forms of Nitrogenous Compounds for the Growth of Plants.—Prof. Mærcker.—The best result, apparently on oats, was obtained with soda-saltpetre. Ammonium sulphate was somewhat inferior, and the yield of grain weaker. Horn-meal and blood-meal delayed the harvest fourteen days, the maturity of the crop being unequal. Ground leather, fermented or unfermented, gave a crop little better than where no nitrogenous manure was applied.

Reports on Fraudulent Manures.—Dr. Stutzer, Prof. Reichardt, and Prof. Emmerling.—An account of the composition of various chemical manures, offered at prices far exceeding their value. A "Silicic Poudrette," sold at £6 per ton, contains:—Total phosphoric acid, 0·2; nitrogen, 0·3; potassa, 0·15; and, on the other hand, sand and clay, 82·8 per cent; and silica, soluble in alkali, 11·05. A special beet manure, sold at £1 2s. per kilo. (!), is applied by dissolving 4, or in case of poor soils, 5 grms. (*sic*) in 10 litres water, and sprinkling the field.

The Application of Soda Saltpetre and Ammonium Sulphate in the Cultivation of the Beet.—O. P. Dehérain.—The author's experiments would seem to prove that sulphate of ammonia has a distinctly injurious action—a result which stands in need of explanation.

Experiments on the Continuous Cultivation of Wheat and Barley at Woburn.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

Stassfurt Salts for Sprinkling in Stables.—Prof. Mærcker.—All the Stassfurt salts prevent the volatilisation of ammonia and the escape of free nitrogen. Those which contain large proportions of magnesium chloride are not to be recommended, as they deliquesce and bring on inflammation in the feet of horses, &c. Kainite, or krugite, is therefore to be recommended.

Action of Amido Compounds on Animal Nutrition.—N. Zuntz.—Asparagin decreases the decomposition of albumen in the system; tyrosine, taurine, and guanidine sulphocyanide have a contrary effect.

The Physiological Action of Copper upon the Organism of Domestic Ruminants.—MM. Ellenberger and Hofmeister.—The statements of Galippe, Burq, and Decom, that copper in small doses, *i.e.*, such as do not produce violent local action, is comparatively harmless, do not hold good as regards the ruminants. The elimination of copper takes place chiefly by way of the gall. It is principally deposited in the liver and the pancreas.

Sunflower Cake as Food for Milch Cows.—Dr. Schrodt and H. v. Peter.—The total production of milk was found to be reduced by the consumption of sunflower seed cake.

Observations on Splenic Fever and Protective Inoculation.—MM. Müller, Archangelski, and Feltz.—From July 1, 1882, to May 14, 1883, there have died at Packisch, 2·41 per cent inoculated cows, 1·50 per cent inoculated sheep, and 4·65 per cent non-inoculated sheep. Of 31 cattle inoculated at Gorsleben there have died of splenic fever 9 68 per cent from August 14, 1882, to June 1, 1883. A bull which had recovered from a slight fever, was attacked again in March, 1883, and died.

Journal für Praktische Chemie.
New Series, Vol. xxviii., Parts 5 and 6, 1883.

The Products of the Dry Distillation of Para-oxybenzoic Acid.—A. Klepl.—When para-oxy-benzoic acid is distilled, the half of it only is resolved into phenol and carbonic acid. The principal products are, with elimination of water, para-oxy-benzoyl-para-oxy-benzoic acids, and finally para-oxy-benzide. A small quantity of para-oxy-benzoic phenyl-ether is formed. Para-oxy-benzide, when submitted to dry distillation, yields phenyl-para-oxy-benzoic phenyl-ether, from which phenyl-para-oxy-benzoic acid is readily obtained. Para-oxy-benzoic and oxy-benzoic acids can be easily converted into sulphonic acids by means of sulphuric acid. The sulphones may then be directly converted into very sparingly soluble acid potassium salts, and separated from the sulphuric acid.

Synthesis of Lecithine.—F. Hundeshagen.—The author's object was to ascertain whether lecithine is a salt or an ethereal compound of an acid with an alcohol base. He has obtained an isomer of lecithine, acid næurine distearyl-glycerin-phosphate.

Physical Chemistry of the Blood.—G. Hüfner and R. Zülz. The object of the authors is to find a method for the quantitative determination of the hæmoglobine, which, on shaking up dilute solutions of this colouring-matter with atmospheric air containing variable proportions of carbon monoxide, enters into combination with the latter gas. The paper is accompanied by an illustration showing the apparatus made use of.

Pyridine in Commercial Ammonia.—H. Ost.—For the detection of this impurity the author neutralises partially with hydrochloric acid, when the pyridine is revealed by its odour. The liquid thus imperfectly neutralised may be distilled, the distillate received in hydrochloric acid, evaporated to dryness, and the alcoholic extract, after expulsion of the alcohol, precipitated with platinum chloride. After the platinum-ammonium compound has been removed the double pyridine compound crystallises out in smooth ramifying orange-red anhydrous prisms.

Journal de Pharmacie et de Chemie.
Tome viii., October, 1883.

Toxic Action and the Therapeutic Use of Potassium Dichromate (Concluded).—M. Vulpian.—A purely medical memoir.

Note on Styrax.—A. Ferrand.—A pharmacographical paper.

Observations on the Action of Glycerin on certain Ethereal Solutions.—C. Méhu.—In analytical researches the presence of glycerin may prove an obstacle to the extraction of certain products by ether.

Nitro-Derivatives of Ethylene Hydride.—A. Villiers.

Memoir on Flour.—M. Balland.—Already noticed.

Volumetric Determination of Carbon Disulphide in the Sulphocarbonates.—E. Falières.

Substitution of Verdigris.—N. Gille.—A neutral copper acetate is at present sold as sub-acetate. It is a greenish blue crystalline powder, of an immediately harsh metallic flavour, and effloresces in dry air. It is entirely soluble in water.

Ichthyol.—This compound is now obtained by the distillation of a bituminous mineral found at Seefeld in Tyrol, and rich in fossil fishes.

Waters contaminated by the Drainage of Cesspools.—M. Balland.—Into a tube 60 to 80 centimetres in length and 15 millimetres in width, and closed at one end, the author pours a few c.c. of a solution of sodium hypobromite. He fills it up completely with the water to be examined, applies the thumb to the surface so as not to admit any air, inverts the tube, and places it in a large glass containing mercury. If urea is present small bubbles of nitrogen gradually rise in the tube, and collect at the upper (closed) end.

MISCELLANEOUS.

Society of Arts.—The 130th Session of the Society of Arts will commence on the 21st inst., with an opening address from Sir William Siemens, the Chairman of the Society's Council. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting, and for these the following arrangements have been made:—November 28th, A. J. R. Trendell, "The International Fisheries Exhibition of 1883;" December 5th, Thomas T. P. Bruce Warren, "The Manufacture of Mineral Waters;" December 12th, Thomas Fletcher, F.C.S., "Coal-gas as a Labour-saving Agent in Mechanical Trades;" December 19th, W. H. Preece, F.R.S., "The Progress of Electric Lighting." There will be six courses of lectures delivered during the Session, under the bequest of Dr. Cantor. These will be—1st, "The Scientific Basis of Cookery," by W. Mattieu Williams, F.C.S.; 2nd, "Recent Improvements in Photo-Mechanical Printing Methods," by Thomas Bolas, F.C.S.; 3rd, "London Houses," by Robert W. Edis, F.S.A.; 4th, "The Alloys used for Coinage," by Professor W. Chandler Roberts, F.R.S., Chemist of the Royal Mint; 5th, "Some New Optical Instruments and Arrangements," by J. Norman Lockyer, F.R.S., F.R.A.S.; and 6th, "Fermentation and Distillation," by Professor W. Noel Hartley, F.C.S. The usual short course of Juvenile Lectures will be delivered during the Christmas holidays. The subject will be "Crystals and Crystallisation," and the lecturer Mr. J. M. Thomson, of King's College, London.

Liquid for Determining the Specific Gravity of Minerals.—Nearly all natural minerals are heavier than water, and therefore sink in it. But when they are placed in a heavy liquid which does not dissolve them, some sink and others float. If two minerals of unlike gravity occur in the same rock, they can be separated by pulverising the rock and putting them in a liquid intermediate in weight between both. A new liquid for this purpose has been devised by C. Rohrback, having a density of 3·57. It is an iodide of barium and mercury, and is prepared as follows:—100 parts of iodide of barium and about 130 parts of red iodide of mercury are mixed with about 20 c.c. of distilled water, shaken, and heated on an oil-bath to 150° or 200° C, until dissolved, and then concentrated until it will float a crystal of topaz. After standing several days the clear liquid is decanted and filtered. It has a yellow colour, boils at 145° C., and refracts light strongly. It can be used for separating axinite, kyanite, in part, epidote, heavy mica, some garnets, and nearly all hornblendes; also jade, olivine, orthite, nearly all members of the pyroxene group, saussurite, titanite, topaz, heavy tourmaline, vesuvianite, and basaltic rocks. In diluting it to obtain any special density, it is mixed with a dilute solution of the same, so as to avoid precipitation. After the separation the powdered minerals are washed with a few drops of iodide of potassium.—*Wiedermann's Annalen.*

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Detection of Traces of Gold.—(Reply to J. C.)—Sonstadt, CHEMICAL NEWS, vol. xxvi., p. 159; particularly footnote to second column, page 160.—W. H. DARLING.

MEETINGS FOR THE WEEK

SATURDAY, 10th.—Physical, 3. "Some Experiments on the Velocity of Sound in Air," by J. Blaikley. "On the Moment of a Compound Magnet," by R. H. M Bosanquet. "On Measurements relating to the Electric Resistance of the Skin, and to certain Medico-electric Appliances," by W. L. Carpenter.

THURSDAY, 15th.—Chemical, 8. "On the Estimation of Starch," by C. O'Sullivan. "On the Products of Decomposition of Solutions of Ammonium Nitrite by Heat," by G. Stillingfleet Johnson.

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1251.

A NEW RESIDUAL PRODUCT FROM THE DISTILLATION OF COAL.

By GEORGE E. DAVIS.

THE distillation of coal, or rather, as it is generally termed, its carbonisation, is scarcely a century old, and from the very first days of the industry up to the present, nearly the sole aim has been the production of illuminating gas, the tar and the ammoniacal liquor being termed residual products. From time to time there have been proposals to turn the gas into a residual and go in for making tar-water only, and by increasing the yields of these, and by utilising the gas under the retorts, to manufacture sulphate of ammonia and tar products simply. For some reason or another these projected schemes have never been successful, for the simple reason that tar distilled from coal at a low temperature is not as good as ordinary tar, and with low temperatures the yield of ammonia water is not usually so great as with higher heats. It is true that a considerable revenue may be derived from the sale of coke, but taking all things into consideration there has been so slight a margin, except in special situations, such as distillation on the pit-bank, that but few capitalists have been induced to embark in the undertakings.

The older analyses of coal-gas gave us a very poor insight into its real composition. Bunsen in his "Gasometry," gave us elaborate methods and calculations respecting the analysis of coal-gas, but recent experiences have shown that many of the deductions are not worth the paper they are printed on. The real and most important illuminating constituents of ordinary coal-gas were entirely overlooked, and so many a practical worker was misled.

Our smoke and fog question, which has cropped up annually, has brought before our notice the gradually advancing use of gas for heating and cooking purposes, and it is evident that the gas for such purposes need not depend for its excellence upon its illuminating power. In fact its power to deposit carbon during combustion is a defect both for cooking and heating, and the use of a gas deprived of its more condensable hydrocarbon vapours would offer many advantages over the old system.

Now reference to the published analyses of coal-gas would, in most cases, lead us to believe that such a task would be impracticable as a manufacturing operation. We are told that the greater portion of the illuminants were olefiant gas, ditethyl, &c., or liquids of such low boiling-point as to be reckoned practically with the permanent gases. Investigations extending over a lengthened period have shown me that all the previous analyses of coal-gas are of no value and are moreover inaccurate. The *chief* illuminants are vapours of easily condensable hydrocarbons commencing to boil at below 18° C., and containing many hydrocarbons, even up to solid naphthalene. Now these "illuminants" are easily absorbed by olive oil or rape oil and even by hydrocarbon oils, and it has been found by many experiments that as much as five gallons of these condensed hydrocarbons can be obtained from the gas yielded by one ton of coal.

These hydrocarbons are worth much more than the original coal, plus materials and labour; therefore it seems a very profitable undertaking when the gas is required for cooking and heating purposes, first to extract the illuminating hydrocarbons. This can be done so completely that the gas on combustion yields only a flame of exceedingly fable luminosity, this being due to the small quantity of what we may call permanent gases still remaining.

It is clear, then, that in the treatment of coal for heating purposes we have another residual product, if the process is so conducted as to eliminate the illuminating vapours. I propose to call it *crude benzol* in contradistinction to the *crude* naphtha, or first runnings of coal-tar.

Many of you will be aware that a process of carbonisation for the sake of these products is now most successfully carried on in the Midlands, and the process has a great future before it; but I have learned by experience that it is only those who can carry on their processes in an exact and scientific manner, and who can obtain the most from their raw material, who are likely to succeed to the end. The differences of temperature, both in retorts and out of them, lead to such variation in the quality of the crude benzol produced as to clearly point to the fact that these operations must be more carefully attended to than in ordinary gas-making.

Ordinary gas coal of good quality should yield over four gallons of this residual product, and it is very probable that before long a large quantity of it will be sent into the market. Buyers should, however, be cautious; if the heat is too low, more paraffins are formed, and this is only to be discovered by special tests. The ordinary process of distillation and catching all that which distils over at certain mean temperatures is inadequate to discover the presence of paraffins. These are, however, proved by the short yield of aniline oil produced from the benzol in question.

My object in making these few remarks is owing to having heard that carbonising is a failure, which statement can only have been made by those unacquainted with what is really going on. I am sorry I cannot go more fully into details concerning my own process, but as I intend reading an exhaustive paper at a future date upon the subject, you will soon be able to read it in the admirable journal of our Society.

CLERGET'S METHOD OF SUGAR ANALYSIS BY INVERSION.

By ALFRED J. KING.

PERHAPS the clearest exposition of the *rationale* of the above process is given by Casamajor in the CHEMICAL NEWS, vol. xlv., p. 148. He there points out that if we have a sugar containing:—

(1) Cane-sugar C
(2) Invert-sugar.. I
(3) Other right rotating bodies G
(4) Other left rotating bodies .. H
(5) Inactive bodies

and if the direct test in the optical saccharimeter gives a deviation D, then $D=C-I+G-H$, in which equation the only known quantity is D, and we want to find C. Further, by the action of the acid, C disappears, and is replaced by a quantity, *i*, representing the left rotation of the invert-sugar produced from the cane-sugar originally present: hence if the values, $-I+G-H$, remain constant, and D' be the reading after inversion, we have now—

$$D' = -i-I+G-H,$$

and, assuming the truth of these two equations, the value of C is easily found to be—

$$C = \frac{100\,(C+i)}{144-\frac{t}{2}}$$

As Casamajor correctly states, this equation does not hold good unless the values of $-I+G-H$ are constant in the two preceding equations, but the point to which I wish to draw attention is this, that I think that not only he but most other writers have overlooked one important condition of such a constancy. It is usually assumed that these values must remain unaltered unless the acid used for inversion has some specific action upon the rotatory power of the substances whose rotations they repre-

sent. With regard to +G and −H this is probably true, but with regard to −I there is one other condition which must be attended to. Now −I represents the left-handed rotation due to invert-sugar, and the rotatory power of invert-sugar varies with the temperature. Hence, in order that −I shall be the same in both equations, the temperature of the solution at the time of reading must be the same before and after inversion. This seems so self-evident a proposition that I should not have thought it worth calling attention to, but that I find no reference to it in any account of Clerget's process that I can get hold of. Very particular instructions are given to note the exact temperature of the solution after inversion, but nothing is said as to the temperature at which the direct reading is made. Doubtless, in most cases of raw sugars and natural syrups where the percentage of invert-sugar originally present is but small, the error that might arise from neglect of this precaution could not be great; but the case is quite different with a syrup which contains from 20 to 30 per cent of invert-sugar. The overlooking of this point by those who have used the Clerget process may be the cause of the unfavourable opinion expressed of it by certain authors.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE, AND THE INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

(Continued from p. 221).

Influence of Ammonia.

April, 1883. Series N.—Solution from the salt crushed and pressed, December, 1882. Mg Mix. from burette.

Six Experiments.—In each, added the 10 c.c. No. 1 NH_3 before precipitating. All other conditions same as tests.

Twelve tests. Ammonia added after precipitation as usual.

No. of Expt.	NH_3 before precipitating.	No. of Expt.	Tests.	No. of Expt.	Tests.
N 179	100·10	N 185	100·05	N 191	100·20
180	99·90	186	100·10	192	100·20
181	100·20	187	100·20	193	100·20
182	100·20	188	100·25	194	100·20
183	100·15	189	100·20	195	100·05
184	100·15	190	100·20	196	100·20
Average	100·12	Average	100·17	Average	100·18

April, 1883. Series O.—Solution from the salt crushed only December, 1882. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. solution micro. salt 55 c.c. water and 10 c.c. No. 1 NH_3. Precipitated. When the precipitate had settled, added 20 c.c. No. 1 NH_3. Other conditions same as tests.

Twelve tests. As usual.

No. of Expt.	10 c.c. No. 1 NH_3 before precipitating. 20 c.c. after.	No. of Expt.	Tests.	No. of Expt.	Tests.
O 197	99·95	O 203	100·05	O 209	100·00
198	100·00	204	100·05	210	99·95
199	100·00	205	100·10	211	100·20
200	100·10	206	100·20	212	100·20
201	100·00	207	100·10	213	100·20
202	100·15	208	100·20	214	100·20
Average	100·03	Average	100·12	Average	100·13

April, 1883. Series P.—Solution from the salt in its original condition. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. solution micro. salt, 85 c.c. ammonia water containing 11·54 per cent NH_3. Precipitated with 12 c.c. Mg Mix. No. 1.

Twelve tests.—As usual.

No. of Expt.	Precipitated in presence of much Ammonia.	No. of Expt.	Tests.	No. of Expt.	Tests.
P 215	99·55	P 221	100·05	P 227	100·00
216	99·60	222	100·05	228	100·00
217	99·75	223	100·05	229	100·00
218	99·70	224	100·00	230	100·25
219	99·60	225	99·95	231	100·20
220	99·60	226	100·05	232	99·90
Average	99·63	Average	100·03	Average	100·06

When the P_2O_5 is precipitated in presence of much NH_3 the precipitate is very voluminous and tedious to wash. As the dilute ammonia would lose strength during the protracted washing, I washed Nos. 217, 218, 219, and 220 each with 200 c.c. No. 2 NH_3, and protected from the air as much as possible. Nos. 215 and 216 were each washed with 200 c.c. No. 3 NH_3, as of course were all the tests.

Solvent Action of No. 2 NH_3 on the Precipitate.[c]

May, 1883. Series Q.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette. Eighteen experiments were made, but as one of the first three was lost I rejected the other two.

Five Experiments.—In each, washed the precipitate with 200 c.c. No. 2 NH_3. Other conditions same as tests.

Five Experiments.—In each, washed the precipitate with 600 c.c, No. 2 NH_3. Other conditions same as tests.

Five Tests, Washed as usual with No. 3 NH_3.

No. of Expt.	Washed with 200 c.c. No. 2 NH_3.	No. of Expt.	Washed with 600 c.c. No. 2 NH_3.	No. of Expt.	Tests.
Q 233	100·10	Q 238	99·55	Q 243	99·90
234	99·85	239	99·55	244	99·90
235	100·05	240	99·65	245	100·05
236	100·15	241	99·60	246	100·00
237	100·05	242	99·75	247	100·00
Average	100·04	Average	99·62	Average	99·97

May, 1883.—Series R.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette. Repeated eighteen experiments as above.

No. of Expt.	Washed with 200 c.c. No. 2 NH_3.	No. of Expt.	Washed with 600 c.c. No. 2 NH_3.	No. of Expt.	Tests.
R 248	99·95	R 254	99·50	R 260	100·05
249	100·00	255	99·55	261	100·00
250	99·95	256	99·65	262	99·85
251	100·10	257	99·75	263	99·95
252	100·05	258	99·60	264	100·00
253	100·15	259	99 70	265	100·05
Average	100·03	Average	99·62	Average	99·98

Precipitation of P_2O_5 in presence of ammonium oxalate and with slight and large excess of Mg. Mix., and precipitating in presence of ammonium oxalate and NH_4Cl with slight excess of reagent.

March, 1883. Series S.—Solution from the salt crushed and pressed, December, 1882. Mg Mix. from burette.

[c] Results of experiments on the solvent action of No. 3 NH_3 will be referred to further on.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3, 1 gramme ammonium oxalate, 12 c.c. Mg Mixture No. 1.

Six Experiments.—In each, proceeded as above, except that only 0·25 gramme ammonium oxalate was employed.

Six Tests.—Modified; *i.e.*, the NH_3 added before instead of after precipitating.

No. of Expt.	1 grm. $NH_4O,\overline{O}$. 12 c.c. Mg Mix.	No. of Expt.	0·25 grm. $NH_4O,\overline{O}$. 12 c.c. Mg Mix.	No. of Expt.	Tests Modified.
S 266	99·40	S 272	99·70	S 278	100·00
267	99·25	273	99·75	279	100·00
268	99·30	274	99·80	280	100·00
269	99·20	275	99·80	281	100·00
270	99·35	276	99·75	282	100·05
271	99·35	277	99·95	283	100·20
Average	99·31	Average	99·79	Average	100·04

March, 1883. Series T.—Solution from the salt crushed and pressed, December, 1882. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3, 1 grm. oxalate ammonium, 33 c.c. Mg Mixture No. 1.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3, 1 gramme NH_4Cl, 1 gramme ammonium oxalate, 12 c.c. Mg Mixture No. 1.

Six Tests.—Modified.

No. of Expt.	1 grm. $NH_4O,\overline{O}$. 33 c.c. Mg Mix.	No. of Expt.	1 grm. $NH_4O,\overline{O}$. 1 grm. NH_4Cl. 12 c.c. Mg Mix.	No. of Expt.	Tests Modifid.
T 284	99·25	T 290	99·25	T 296	100·05
285	99·30	291	99·00	297	100·05
286	99·65	292	99·25	298	100·05
287	99·45	293	99·10	299	100·10
288	99·75	294	99·10	300	100·10
289	99·70	295	99·25	301	100·10
Average	99·52	Average	99·16	Average	100·07

August, 1883. Series U.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3, 0·5 grm. ammonium oxalate, 15 c.c. Mg Mixture No. 1 from burette. Let settle, then added 25 c.c. Mg Mixture No. 2 from the measure, 4 or 5 c.c. at a time, stirring well after each addition.

Six Experiments.—In each proceeded as above, except that at the end added 50 c.c. instead of 25 c.c. Mg Mixture No. 2 from the measure, about 10 c.c. at a time.

Six Tests.—Mg Mixture from burette.

No. of Expt.	0·5 grm. $NH_4O,\overline{O}$. 15 c.c. Mg Mix. No. 1. 25 c.c. Mg Mix. No. 2.	No. of Expt.	0·5 grm. $NH_4O,\overline{O}$. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Expt.	Tests.
U 302	99·70	U 308	99·55	U 314	100·20
303	99·75	309	99·75	315	100·25
304	100·05	310	99 85	316	99·95
305	100·20	311	100·00	317	99·80
306	99·90	312	100·20	318	100·20
307	99·75	313	100·10	319	100·00
Average	99·89	Average	99·91	Average	100·07

Solvent action of ammonium oxalate on the precipitate, and influence of Mg Mixture in counteracting this.

July, 1883. Series V.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, washed the precipitate first with 50 c.c. No. 3 NH_3, then with 110 c.c. of solution composed of 100 c.c. water, 1 grm. ammonium oxalate, and 10 c.c. No. 1 NH_3. Finally, washed with 150 c.c. No. 3 NH_3. Other conditions same as tests.

Six Experiments.—In each, proceeded as above, except that to the solution containing 1 gramme ammonium oxalate, I added 20 c.c. Mg Mixture No. 2.

Six Tests.

No. of Expt.	Washed with sol. containing 1 grm. $NH_4O,\overline{O}$.	No. of Expt.	Washed with sol. con. 1 grm. $NH_4O,\overline{O}$ and 20 c.c. No. 2 Mg Mix.	No. of Expt.	Tests.
V 320	97·05	V 326	99·85	V 332	100·10
321	96·95	327	100·10	333	99·90
322	97·15	328	100·10	334	100·10
323	96·95	329	99·95	335	99·85
324	96·80	330	100·10	336	99·95
325	96·85	331	100·05	337	100·05
Average	96·96	Average	100·02	Average	99·99

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

SILICON.

ALTHOUGH Berzelius† attempted to ascertain the atomic weight of silicon, first by converting pure Si into SiO_2, and later from the analysis of $BaSiF_6$, his results were not satisfactory. We need only consider the estimations of Pelouze, Schiel, and Dumas.

Pelouze,‡ experimenting upon silicon tetrachloride, employed his usual method of titration with a solution containing a known weight of silver. 100 parts of Ag gave the following equivalences of $SiCl_4$:—

39·4325
39·4570

Mean $39·4447 \pm 0·0083$

Hence Si = 28·408.

Essentially the same method was adopted by Dumas,|| Pure $SiCl_4$ was weighed in a sealed glass bulb, then decomposed by water, and titrated. The results for 100 Ag are given in the third column:—

2·899 grms.	$SiCl_4$	= 7·3558 grms.	Ag.	39·411
1·242	,,	3·154	,,	39·379
3·221	,,	8·1875	,,	39·340

Mean $39·377 \pm 0·014$

Hence Si = 28·117.

Dumas and Pelouze's series combine as follows:—

Pelouze	$39·4447 \pm 0·0083$
Dumas	$39·377 \quad 0·014$
General mean	$39·4265 \pm 0·0071$

Hence $SiCl_4 = 169·810 \pm 0·034$.

Schiel,§ also studying the chloride of silicon, decomposed it by ammonia. After warming and long standing it was filtered, and in the filtrate the chlorine was estimated as

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† "Lehrbuch," 5 Aufl., 3, 1200.
‡ *Comptes Rendus*, 20, 1047. 1845.
|| *Ann. Chem. Pharm.*, 113, 31. 1860.
§ *Ann. Chem. Pharm.*, 120, 94.

AgCl. 100 parts of AgCl correspond to the quantities of $SiCl_4$ given in the last column:—

0·6738 grm. $SiCl_4$	gave	2·277 AgCl.	29·592
1·3092 „		4·418 „	29·633
		Mean	29·6125 ± 0·0138

Hence $SiCl_4 = 169·437 \pm 0·080$, and Si = 27·957.

Combining the values for $SiCl_4$ we have this result:—

Pelouze and Dumas	$SiCl_4 = 169·810 \pm$	0·034
Schiel	„ = 169·437	0·080
General mean	„ = 169·675	0·031

Hence Si = 28·195 ± 0·066; or, if O = 16, Si = 28·260.

It will be observed that all of these determinations rest upon the composition of $SiCl_4$, a compound for which it would not be easy to guarantee absolute purity. All the errors likely to occur in the determination of the atomic weight would be plus errors, so that the value deduced above is almost certainly too high.

DETERMINATION OF THE EQUIVALENTS OF METALS BY MEANS OF THEIR SULPHATES.

By H. BAUBIGNY.

If the determination of the equivalents of the metals by means of their sulphates has already been attempted several times, many of these determinations have not presented the agreement to be desired. The cause of these discrepancies lies in the difficulty often found in obtaining sulphates chemically neutral and always constant in composition. By successive crystallisations they can but rarely be completely freed from the last traces of free acid; some of them are even decomposed by water, and for expelling the excess of acid heat is necessary. But if it is too high there may be partial decomposition of the sulphates and the experiment may be vitiated by errors in the opposite direction. The employment of a method of heating by which the sulphates may be submitted indefinitely to a temperature constant and relatively high, but below that of their decomposition, is the first condition for securing to this kind of determination all the precision which it requires.

The use of the sulphur-bottle realises this condition. By numerous experiments the author has shown that, with the exception of the sulphates of gold and of the platinum group, which he has not studied, this class of salts possesses a stability so great that they may be kept for entire days at a temperature notably higher than the boiling point of sulphuric acid, and that even at this temperature of 440° certain sulphates only lose the last traces of free acid very slowly, and that there is room for employing certain artifices for accelerating the elimination of this acid.

This process constitutes a precise and exact method, since it enables us to avoid any overheating capable of producing incipient decomposition, and removes all doubt as to the state of the salt to be operated upon. The author has thus obtained without difficulty ferric sulphate as a perfectly definite salt of a rosy white.

The preparation of neutral anhydrous sulphates becomes under these conditions as rapid and perhaps even more certain than that of the chlorides which are also capable of retaining an excess of acid, or, if their hydrates are heated, of forming basic salts, unless we confine ourselves to the most laborious conditions of preparation.

When the sulphates are thus obtained, their analysis constitutes the second and last stage of the operation. If we take account of the decomposition of these salts by heat by the loss of their acid, as Boussingault demonstrated in 1867, by operating in a furnace heated with the blowpipe, this analysis may reach a high degree of perfection, for it is reduced to a calcination and two weighings, that of the sulphate with the boat in which it has been prepared (the tare of which is known), and that after calcination, which shows the loss of the acid and the weight of the oxide which remains, *i.e.* the proportion of the weights of the acid and the base.

This method of analysis by the dry way, which does not require any manipulation of the matter outside the boat which contains it, thus excluding all causes of error inherent in determinations by the moist way, permits of a greater precision than the processes of the latter kind. This analytical method is also of more easy execution than the determination of equivalents by the synthetic method, *i.e.* the transformation of a known weight of metal or oxide into sulphate—an operation in which there is danger of losses, as Berzelius and Stas declare in their remarks on the extreme difficulty of bringing such a synthesis to a good conclusion.

This process is defective only when the sulphates themselves are volatile with or without decomposition; as those of potassium, sodium, thallium, and mercury, or when the bases themselves are volatile at high temperatures, as baryta and strontia. The determination by the moist way, or that by synthesis, are then the only expedients possible, and in the latter case the last traces of free acid are expelled, before weighing the salt, by heating in the sulphur-stove.

As for the oxides capable of becoming oxidised in the air under the influence of heat, the way of dealing with this property is sufficiently well known.

The solution of the pure sulphate is evaporated in a platinum vessel, protected from the dust of the air, as recommended by M. Stas. Part of the salt is introduced into a tared platinum boat, which is allowed to slide into a glass tube, the open extremity of which alone projects out of the sulphur-stove. It is kept at this temperature until two consecutive weighings, made at an interval of several hours, are constant. For these weighings the sulphate is let cool, protected from the moisture of the air, by cleaning the glass tube at the moment when it is withdrawn from the stove.

The time which is required for the elimination of the excess of acid varies according to the kind of sulphates and the quantity operated upon. In general, a constant weight is reached more rapidly if the sulphate is in a pulverulent state. When this last point is reached the boat is put at the bottom of a platinum tube, which is placed in a muffle, so that the open end of the tube projects slightly from the mouth of the muffle. Heat is then gradually applied up to the temperature necessary for the total decomposition of the sulphate.

The use of the platinum tube has a double purpose: 1, to ascertain by examination of this tube if there has been any loss of spirting; 2, to withdraw the oxide, if reducible, from reducing action by permitting the access of the external air around the oxide; the internal atmosphere of a muffle heated with gas and closed having almost always a reducing action.

The author has never met with a trace of spirting in his determinations, and considers that if the temperature is raised gradually it never occurs with sulphates free from excess of acid.

The elimination of the acid is only considered as complete when the weighings, after two successive calcinations, give the same results. This does not exclude a counter-experiment by the moist way, *i.e.* the re-solution of the oxide in hydrochloric acid, and the application of a few drops of barium chloride to the diluted and heated solution.

In order to weigh the oxide the muffle is let cool down to dull redness, and at this moment the boat is rapidly withdrawn from the platinum tube and let slide into a glass case, previously heated in the sulphur-bottle. The case is closed and the boat weighed when cold.

In a future paper the author proposes to show the application of this method to copper, zinc, nickel, iron, aluminium, and chromium.—*Comptes Rendus* (Oct. 15th, 1883).

IODINE IN COD LIVER OIL.

BY EDWARD C. C. STANFORD, F.C.S.

"IT is proposed to verify the statement in Garrod's "Materia Medica" that cod liver oil contains 0·06 per cent. of iodine." See "Blue List."

If this statement were true, cod liver oil would be one of the richest sources of iodine with which we are acquainted. At present the marine algæ form the only commercial European source of iodine. The largest quantity of iodine found in the deep sea tangle or stems of *Laminaria digitata* amounts in the fresh plants to about 0·1 per cent. The quantity obtained when this plant is burned into kelp seldom reaches 0·05 per cent. The average yield from laminaria drift on the large scale is 0·025 per cent., but many thousands of tons of seaweed have been made into kelp and worked for iodine, which have not yielded more than 0·005 per cent., and some even less than this, so that we have to deal on the large scale with a material, and constantly to test samples, containing very small percentages of iodine. I mention this in connection with the process daily employed for many years in estimating small amounts of iodine in our laboratory, and which has also been employed in obtaining the results from cod liver oil to be published in this paper.

Much difference of opinion has arisen amongst former observers with regard to iodine in cod liver oil, and the statements of results are extremely conflicting, some chemists having failed to find iodine at all, others only in some specimens of this oil. Other chemists again have estimated the proportion of iodine as much higher than the quantity above indicated; and it has been assumed that this element represents an important factor in its medicinal value.

In a well known work on materia medica the editors remark that the state of combination in cod liver oil "may, perhaps, tend to develop a peculiar action of iodine and bromine, and endow them with an efficacy not otherwise attainable."

The following results have been published at various times by the authorities quoted:—

	Iodine per cent.
Dorvault found in cod liver oil	0·150
Raie found in cod liver oil	0·180
Joseph found nearly ½ per cent.	0·487
Machenroden found	0·162 to 0·324
Grager found in light brown oil	0·0846
Dr. de Jongh found in pale oil	0·0374
" " pale brown	0·0406
" " brown	0·0295

All these are extremely high and improbable.

Mr. Mitchell Bird (*Pharm. Journ.*, [2], i., p. 546) gives results of analyses of six varieties of cod liver oil, which are much nearer what I believe to be the truth. The method and the results differ considerably from mine, although we are both agreed in the fact that we have found iodine in all the specimens examined.

The percentage results are as follows, the iodine being calculated as potassium iodide:—

	As KI.		As Iodine.
1. Cod liver oil, Norway ..	0·0021		
2. Cod liver oil, Norway ..	0·0018	average	
3. Cod liver oil, Norway ..	0·0016	0·001775	0·001355
4. Cod liver oil, Norway ..	0·0016		
5. Cod liver oil, Newfoundl'nd	0·0012	average	
6. Cod liver oil, Newfoundl'nd	0·0014	0·0013	0·000993

He used 5000 grs. of the oil for each experiment, and saponified with alcoholic solution of caustic potash, burned the soap formed and dissolved out the salts; after saturating the solution with sulphuric acid and separating the potassium sulphate deposited, he employed the starch test, setting free the iodine with nitrite of potassium and sulphuric acid, and comparing the colour with standard solutions of potassium iodide. My method is different; it is a delicate process of very general application, and one that I adopted some years ago, having discarded all others in its favour. I will describe it here as applied to kelp, one of the most troublesome and various of all commercial substances to sample and test.

To ensure an accurate sample about 100 lbs. are carefully picked from a cargo of say 100 tons, and ground up. Of this 100 grains are taken to estimate the moisture, and another 100 grains to estimate the soluble matter, the potash, and the iodine. The kelp is treated with about 4 ounces of hot water, which dissolves little or none of the oxysulphides; this operation is repeated, the residue washed, and the solution made up to 5000 grains measure. Of this 1-10th part or 500 grains measure, equal to 10 grs. of kelp, is taken for estimating the iodine, so that we never operate on more than 1-10th of a grain of iodine, generally 1-20th, often 1-100th. In fact, if the amount present exceeds 1-10th of a grain, we always dilute the solution. 100 grains measure of bisulphide of carbon are added, and a few drops (1 to 3) of nitrosulphuric acid* dropped in. The testings are performed in large even tubes and compared with graduated standard solutions of potassium iodide treated in the same manner. By this method 1-2500000th part is easily detected and measured, and up to 1-10000000th part the estimation is very accurate. If the iodine in a seaweed or other organic substance is to determined, it is carbonised in a small iron retort or crucible, and the charcoal treated in the same way. Burning to ash, however carefully done, involves a considerable loss of iodine, more than is generally supposed. For instance, a sample of seaweed ash exposed for twenty-four hours in an open crucible over an ordinary Bunsen burner will not retain a trace of iodine at the end of that time. We invariably carbonise the material in preference to burning to ash, in order to retain all the iodine and to easily extract the salts. Some of these specimens are extremely difficult, indeed, almost impossible, to burn to complete ash on account of the large proportion of fusible salts present. In estimating the small quantities of iodine necessary in our analyses we are really limited to colour tests. I have long discarded starch, as it introduces an organic substance very liable to change, and in many circumstances unreliable. Moreover, in my hands it is not so sensitive as that with bisulphide of carbon. The solution is not perfectly transparent, and the indications not so sharp. The colour is spread over the whole liquid, and when dilute can only be seen by looking down the length of the tube, whereas in the bisulphide of carbon test it is removed out of the solution and concentrated in a sixth of the volume at the bottom of the tube. The comparison of the two methods is very marked. In testing a solution of potassium iodide containing only 1-2500000th part of iodine, the maximum effect is immediate, and another advantage is that the iodine can be easily separated from its solution in bisulphide of carbon. We usually recover the latter by treating it with zinc in the presence of water. The specimens of cod liver oil experimented on, for which I am indebted to our mutual friend and former President, Mr. Reynolds, were taken in quantities of 5000 grains each, saponified with 1000 grains of caustic soda, pure and free from iodine, then carbonised in a large porcelain crucible; the resulting charcoal was treated with hot water and made up to 5000 grains measure. One-tenth of this or 500 grains was found quite sufficient to detect the presence of iodine, and to estimate it. Three experiments were made, taking 500 grains, 2500 grains, and

* The nitrosulphuric acid is made by treating starch with nitric acid, and passing the nitrous fumes into sulphuric acid, 1·843 sp. gr., to saturation. The mixture keeps very well.

1000 grains respectively, with pretty concordant results. The mean results are appended.

In the first experiment the solution was tested at once in the manner indicated. In the second the solution was neutralised with hydrochloric acid in the presence of the carbon bisulphide, no iodine was eliminated until the nitro-sulphuric acid was added. In the third the solution was neutralised with hydrochloric acid before the addition of the test solutions. Little difference was noticed. The following six specimens were selected :—

No. 1. Cod liver oil, pale.
No. 2. Cod liver oil, Norway.
No. 3. Cod liver oil, manufactured by Carr and Sons, Berwick-on-Tweed.
No. 4. Cod liver oil, English.
No. 5. Cod liver oil, Newfoundland.
No. 6. Light brown cod liver oil.

The mean proportions of iodine found were per cent—

No. 1. 0·000410
No. 2. 0·000434
No. 3. 0·000276
No. 4. 0·000138
No. 5. 0·000315
No. 6. 0·000360

} Mean percentage of iodine, 0·000322.

I also estimated the iodine in fresh cod liver; the fishmonger informed me that it was not in season, but the result is here appended. 5000 grains were treated in the same manner as the oil. Having stated on a former occasion (B. Pharm. Conference, Liverpool) that the oil vomited by the fulmar (*Fulmaris glacialis*)* of St. Kilda, and which, though obtained from a bird, has the reactions of a fish liver oil, contains iodide, I have also estimated this amount. 5000 grains were treated in the same way as the cod liver oil.

Cod liver oil dragées are stated to be made of cod liver from which the oil has been removed; an analysis of these is also appended. 1000 grains or 173 of the dragées were employed saponified and with 200 grains of caustic soda. These are extremely rich in iodine, and would form a valuable source of that element if they can be procured cheap enough to contend with the present low prices. I notice, however, that a box of 250 dragées sells at 5s., and is considered (by the maker) to be equal to 6 pints of oil, so that the quantity employed would be equal to 83 ounces or 36,312 grains, or about seven times the quantity of oil used in the other experiments. It contains one hundred and eighty-seven times the proportion of iodine.

	Per cent.
Fulmar oil contains iodine	0·000095
Cod liver fresh contains iodine	0·000817
Cod liver oil dragées contain iodine ..	0·056366†

It will be noticed that the fresh cod liver contains more than double as much iodine as the mean percentage in the oil. Mr. Gate has kindly sent me an estimate of the yield from his experience of ten years' average of oil from cod liver; it is about 45 per cent, taking the best time, December. The inference is that the liver without the oil would contain a much higher percentage of iodine, as shown, indeed, in the dry dragées. And I shall not be surprised to find as much in the fish. This point is under investigation.

Scotch herring has been said by "Jonas" to contain iodine, and this is also under investigation.

I have received the results of the analysis of fresh cod, herring, and herring brine.

5000 grains of fresh cod were treated with ..	500 grains caustic soda.
*5000 grains of salt herrings were treated with	,, ,,
*5000 grains of herring brine were treated with	,, ,,

* Two determinations were made, one with 500 grains and another with 4500 grains, and the mean taken.

Fresh cod fish contained 0·00016 per cent iodine dry = 0·000829.

Scotch herring salted contained 0·00065 per cent iodine.
,, brine ,, 0·00012 ,, ,,

The cod fish contained 80·7 per cent water.

In the fresh cod fish the analyst for the first time in these experiments was troubled with a large quantity of sulphides, and in this case only was not satisfied with the indication from 500 grains measure, and was obliged to use the larger quantity.

It will be seen that the herring contains four times the amount of iodine contained in the cod fish, and more than in any of the samples of cod liver oil; if, therefore, the iodine be the medicinal element, you should recommend Scotch herring salted; it is very cheap at present.

I find the subject becoming interesting, and, indeed, alarming to the iodine maker, and intend examining other varieties of fresh fish, for I expect to find iodine in all, and, if so, every man who eats fish will become his own iodine eliminator. Specimens of true genuine unmixed whale, seal, and bottlenose oil have been sent me by my friend, Captain John Gray, a celebrated Peterhead whaler, to whom the Arctic regions are a kind of "Winter Garden," and these are under examination, but I cannot yet report the results.

Since the publication of the paper, the following results have been obtained, the respective oils having been treated in the same manner as the cod liver oil :—

	Per cent.
Whale oil, cold drawn, contains iodine	0·00001
Bottlenose ,, ,, ,,	0·00010
Seal ,, ,, ,,	0·00005

—*Pharmaceutical Journal*, November, 1883.

* *Pharmaceutical Journal*, November, 1870.

† In the published analysis of these by Professor Garreau the iodine is estimated at 0·154 per cent, *i.e.*, richer than any other known organic substance.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 10, 1883.

Prof. Clifton, President, in the Chair.

Dr. J. Blaikley read a paper on the "*Velocity of Sound in Air*," in which he described a modification of Dulong's method of measuring it by the wave-length in a pipe lengthened. Dulong did not allow for the partial tones, which are an important factor, whereas Mr. Blaikley does. By means of organ pipes of different diameters the author has found the velocity to be about 320 metres per second. Mean result with four tubes:—One of 54·1 millimetres in diameter: velocity = 329·73 metres per second. One of 32·5 m.m. diameter: velocity = 328·78 metres. One of 19·5 m.m. diameter: velocity = 326·9 metres. One of 11·7 m.m.: velocity = 324·56 metres. The velocity diminishes as the tube is smaller in bore.

Mr. Bosanquet made a communication *on the moment* of a *compound magnet*, which he showed how to measure by the method already published by him.

A compound magnet made up of 18 small cylinders of magnetised steel, placed end to end, is hung in a cradle carried by a delicate bifilar suspension, and placed at right

angles to the magnetic meridian. The deviation from zero produced by the magnet is noted; then the magnet is divided into two parallel rows of nine cylinders along the cradle and the deviation again noted. The tangent of the angle of deviation from the east and west line line multiplied by a constant is the moment of the magnet. The author also pointed out that to define the condition of a permanent magnet it was necessary to know the difference of magnetic potential, the "resistance" of the metal, and the resistance of the external space.

Mr. W. Lant Carpenter read a paper "*On Measurements relating to the Electric Resistance of the Skin, and certain Medico Appliances.*" The author's experiments made upon himself, showed that the resistance of the body amounts to thousands of ohms, but is mainly due to the condition of the epidermis. If this is dry the resistance is high. By soaking the skin in salt and water he reduced the resistance of parts of his body from 10,300 ohms to 935 ohms, after 100 minutes' soaking. He infers that a large electrode should be used in applying electricity to the body, and that the skin should be soaked for 25 minutes previously. Mr. Carpenter also exhibited a "chain band," by Mr. Pulvermacher, and a small voltameter by the same inventor, in which the liberated gases force some of the water up a graduated tube as a gauge of the current. The author drew attention to the necessity of seeing that the skin should be dry in handling some electric light machines, else disagreeable shocks might result.

Professor Ayrton believed that the danger of electric lighting currents lay rather in their discontinuity than their electromotive force. The Brush currents, which have proved fatal, are more discontinuous than those of the Gramme machine, &c. Adverting to the presence of electricity in the air as influencing health, he suggested that the influence might be studied by electrifying the air—say in a hospital ward.

Mr. W. Coffin stated that statically electrifying patients had been tried at Bellevue Hospital, New York, without definite results.

NOTICES OF BOOKS.

The Chemistry of the Secondary Batteries of Planté and Faure (*Nature Series*). By J. H. Gladstone, Ph.D., F.R.S., and Alfred Tribe, F.Inst.C. London: Macmillan and Co.

It is a matter of some difficulty to imagine for what class of readers this little manual of sixty pages has been written. Issued as one of the "Nature" series one would naturally expect the book to be somewhat like the other excellent members of this series, of an elementary character that might be of interest to persons other than those directly connected with electrical science, but, far from this being the case, the matter that is here brought together consists in substance of several communications on the chemistry of secondary batteries, addressed by the authors to the scientific world during the past and present year, with some slight verbal alterations and a few notes explanatory of the experiments.

The subject that is here discussed is certainly one of great importance at the present time as regards the right understanding of the conditions necessary for the economical utilisation of electrolytic action as a source of energy, and is consequently one to which the attention of many physicists and chemists is turned. Unlike the majority of batteries in use the chemical changes that take place in the lead and lead-peroxide cells of Planté and Faure are of a much less simple nature, and this subject, although of vital importance, has to a great extent been disregarded by practical electricians, and as yet the chemical conditions for success are vague. However, all investigations of these matters are valuable, and everyone interested in the adoption of electricity in the industries will feel indebted to the authors for bringing together in this little book the results of their experiments on the chemical changes that occur in the so-called accumulators.

The contents are divided into four parts, the first being on local action, in which is shown the analogy between the negative plate of a Planté secondary battery and the authors' copper-zinc couple as regards its chemical behaviour. The conclusions the authors draw from their experiments on this point are that, "In the Planté or Faure battery local action necessarily takes place on the negative plate, with the production of sulphide of lead," and that "The formation of this sulphate of lead is absolutely requisite in order that the charge should be retained for a sufficient time to be practically available." Parts II. and III. treat of the chemical changes that take place in charging and discharging these batteries, the reactions that occur being expressed in symbols based on experiment. In the succeeding part the formation of plumbic sulphate on the plates is discussed, and the important point as to whether or not this compound is reduced by re-charging the cell is, the authors consider, settled by their experiments in the affirmative.

The concluding section describes their experiments on the influence of strength of acid, temperature, and some other miscellaneous factors relating to secondary batteries, and in an appendix is given some observations on the formation of plumbic sulphate on the plates.

The Patents, Designs, and Trade Marks Act, 1883. By James Johnson, Barrister-at-law, and J. Henry Johnson, Assoc. Inst. C.E. London: Longmans, Green, and Co.

On the first of January of next year there will come into operation the new Act to amend and consolidate the law relating to Patents for Inventions, Registration of Designs and Trade Marks, which will be greeted with some satisfaction by the host of inventors who have hitherto been debarred from obtaining protection for their inventions owing to the excessively high cost that such protection has entailed. This new Act which is about to come ihto force has been gained only after a vast amount of agitating on the part of inventors, and it will not be long before the simplification of procedure and reduction of fees in obtaining a patent will be felt in the industries, as by this means an impetus and great encouragement will be given to inventors who, under the old regulations, might have hesitated to pay the large fees requisite to obtain reasonable protection for their ideas and plans. As the Act is printed and annotated in this little manual before us the would-be inventor has a very clear exposition of the procedure that is required to be gone through in order to obtain his patent rights, and legal points which might appear hazy are carefully explained. In one respect, however, the book is incomplete, for the preface tells us that, "The general rules which the Board of Trade is empowered by the new Act to make for regulating the business of the Patent Office, and the matter placed under the charge of the Comptroller, have not been issued at the time of the publication of this volume. As soon as they make their appearance, a new edition, embodying them, will be published."

With a short introduction giving a synopsis of the principal points in the new Act and a very full index, the book will be of considerable assistance to the inventor.

Chemiker Kalender, 1884.* By Dr. Rudolf Biedermann. Berlin: Julius Springer.

The gradual approach of another year calls forth the customary number of calendars such as the one before us, intended to furnish in the smallest compass facts and data of great service to the chemist. For the fifth year now this excellent little pocket-book with its *Beilage* or supplement is issued to the chemical world, and in the present

* "The Chemists' Calendar."

case several valuable additions and improvements are visible in the contents, although the general method of arranging and classifying the data is not disturbed. Some of the chapters have been revised and altered to some extent, H. Vogel having reconstructed the chapter on spectrum analysis, while H. Arzruni has revised the lengthy section on minerals. Among the numerous tables are given the usual ones for the corrections to be applied for variations of temperature and pressure in gas analysis, conversion of one thermometric scale into another; densities of the solutions of many of the more common compounds, acids, alkalies, and salts, and degrees of solubility; indeed there is scarcely one chemical industry which is not represented by some useful data of one kind or another. The supplement, to which is prefixed a short biography of the late F. Wöhler, is filled with facts and formulæ relating to mathematics, mass and weight, heat, light, and electricity, so far as these matters are connected with chemical science. As an appendix to the supplement is given a series of short notices of the principal educational institutions throughout Germany in which chemical and physical sciences may be studied, with the names of the teachers of the different branches.

CORRESPONDENCE.

YELLOW HYDROCHLORIC ACID.

Sir,—As the colour of commercial hydrochloric acid is a subject which has occupied the attention of your readers lately, the following facts may appear worthy of being added to those already communicated.

Some acid bought as "pure hydrocloric acid" was found to have a deeper tinge of yellow than usual, and to contain small traces of sulphuric acid. It was therefore distilled in order to obtain a pure product. The residue from two litres of the acid left behind in the flask measured about 300 c.c., and was of a full yellow colour. When evaporated to dryness, this yellow acid, which was free from iron, left a white residue. The white solid residue when ignited in platinum gave off acid fumes with charring, and left a considerable percentage of ash of alkaline reaction. The alkaline ash partially dissolved in acid with separation of silica.

In this case the yellow colour of the "pure" acid seems to have been due to organic matter.—I am, &c.,

Thomas Bayley.

Laboratory, 7, Broad Street Corner, Birmingham.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 4.

Microscopic Examination of Printed Calico.—R. Meyer.—The "fast" colouration of textile fibres depends on the penetration of the fibre by the colouring-matter, or the materials which produce it, in a dissolved condition, and its subsequent conversion into an insoluble body. This process can be effected either by the operations of dyeing, or as is more frequently the case in printing, by application and subsequent steaming. Among the steam colours there is a class the fixation of which depends on a quite different principle, *i.e.*, the albumen colours. Insoluble or indifferent colours are mixed with albumen, printed, and steamed. The albumen is coagulated and thus cements the colour to the fibre. In examining printed goods the question may often arise whether the colouring-matter has been produced within the fibre or whether it has been fixed by the aid of albumen. If the swatch is macerated and teased out with a needle, so that the single fibres are separated, they appear on examination with the microscope uniformly coloured through their entire mass, and translucent if they have been steeped in dissolved tinctorial substances. In colours applied by means of albumen the fibre itself appears as perfectly colourless, but in numerous places there are found adhering coloured fragments of albumen.

Density of Chlorine at High Temperatures.—J. M. Crafts.—The author's experiments assign to chlorine, up to 1200°, and under atmospheric pressure, the normal density. This result agrees with that of Prof. V. Meyer.

Isolation of the Poisonous Matter contained in certain Lupins.—C. Arnold.—The author has extracted from lupins a shining brown solid matter, of a pleasant aromatic odour and taste. In water it dissolves slowly, forming a turbid solution. In doses of 10 grms. it produces the usual symptoms of lupinosis, especially acute jaundice.

A Trisulph-acid of β-Naphthol.—I. Levinstein.—The author, having prepared the above-mentioned compound, notices a trisulph-acid of β-naphthol, which C. F. L. Limbach has described in the *Journal of Chemical Industry* and has patented. The author suggests that we have here to do with two isomers.

A Correction.—M. Traube.—The author, referring to a former paper, where de-oxidisable has been printed instead of dys-oxidisable, proposes "brad-oxidisable" in place of the latter term.

Colouring-matters of the Saffranine Series.—R. Nietzki.—The author gives an account of pheno-saffranine, di-ethyl-saffranine, tetra-ethyl-saffranine, and of certain intermediate products of the formation of saffranine.

Phosphorescence of Sulphur.—O. Jacobsen.—The author refers to a number of works in which this phenomenon is mentioned. It was a matter of frequent observation when the old brimstone matches were in use.

Pyro-sulphuryl-chloride.—K. Heumann and P. Kœchlin.—The authors find that the vapour density is, not, as Ogier maintains, constant at half the normal figure from 160° to 442°, but that at temperatures not far above the boiling-point it has the normal density for the formula $S_2O_5Cl_2$. The reactions of pyro-sulphuryl-chloride are also stated.

New Methods of Formation of Pyro-sulphuryl-chloride and of Chloro-sulphonic Acid.—G. Billitz and K. Heumann.—The authors have obtained pyro-sulphuryl-chloride by acting on chloro-sulphuric acid with phosphorus pentoxide.

Tetric Acid.—Wladimir Pawlow.—Mono-brom-methyl-acetacetic ester is carefully freed from hydrogen bromide by washing with water, dried with calcium chloride, and heated to 100° in sealed tubes for five to six hours. The crystalline mass produced, when free from the mother-liquor, is tetric acid of great purity, agreeing in its properties and reactions with that of Demarçay.

Synthesis of the Oxaline Bases.—Br. Radziszewski.—An extensive paper, in which the author gives an account of glyoxal-ethyline and glyoxal-propyline.

Hydroxylamine Reactions.—E. Nägeli.—The author has obtained and analysed mesityloxim, phoronoxim, allyl-acetoxim, suberoxim, and camphoroxim.

Benzil.—M. Wittenberg and V. Meyer.—The author comes to the conclusion that benzil contains only one carbonyl group.

Reduction of the Tungsten Compounds.—Baron v. d. Pfordten.—This paper will be inserted at some length.

Qualitative Detection of Acetal.—M. Grodski.—If a dilute watery solution of acetal is mixed in the usual manner with normal soda and normal solution of iodine, the liquid is perfectly clear. But if the same solution is acidified with a few drops of hydrochloric acid, and if the soda-lye and solution of iodine are then added, there is formed a thick yellow precipitate of iodoform.

Conversion of the Phenoles into Nitriles and Carbon Acids.—V. Merz.—The author and Weith have formerly shown that from the mono-halogen derivatives of the benzol hydrocarbons the corresponding nitriles may be obtained by heating with the metallic cyanides. According to Scrugham, triphenyl phosphate yields, with potassium, benzo-nitril. The neutral phosphoric ethers of the phenoles can be easily obtained from the latter by the action of phosphorus oxy-chloride. The author has therefore induced R. Heim to examine the behaviour of the above-mentioned esters when heated with potassium cyanide. There were formed nitriles, which, on saponification, yielded the expected acids.

Action of Phthalic Anhydride upon Quinoline Bases.—Emil Jacobsen and C. L. Reimer.—The authors assert their priority in the investigation of the results of this reaction, but their analytical results differ somewhat from those of Traub. Their experiments prove the total difference of coal-tar quinoline from the artificial quinoline obtained on Skraup's method and from cinchonine-quinoline.

Action of Chlor-acetic Ether upon Primary Diamines.—J. Zimmermann and M. Kuyrim.—By a reaction of this kind the authors have obtained phenylen-diglycocoll.

Synthesis of Dihydronaphthoe Acid.—H. von Pechmann.—The author mixes benzyl-acetacetic ester with 6 to 8 parts of concentrated sulphuric acid, which has been previously mixed with a few drops of water, and pours it, after standing for several hours, into cold water. A fine white powder is separated, which, when purified by re-crystallisation from ether, is dihydronaphthoe acid.

A Contribution to our Knowledge of the Aromatic Nitroso Compounds.—S. Gabriel.—The author has examined nitroso-indol and ortho-phenyl-nitroso-acetic ethyl.

Derivatives of Allylamine.—C. Liebermann and C. Paal.—A very voluminous memoir which does not admit of useful abstraction.

Oxalines and Glyoxalines.—O. Wallach.—An account of ethyl-glyoxaline, methyl-glyoxaline, oxal-ethyline, chloroxal-ethyline, para-methyl-glyoxaline, the corresponding ethyl compound, para-propyl-glyoxaline, and oxal-ethyline.

Meta-nitro-phenyl-thio-carbimide.—H. Steudemann.—In order to prepare a nitro derivative of phenyl-thiocarbimide, the author dissolves sulpho-urea in hot acetic anhydride, adds water, and boils for a short time, when a heavy oil sinks to the bottom, which on cooling is interspersed with numerous crystals.

Nitro Derivatives of Resorcine.—P. G. W. Typke.—The author used as his starting-point diacetyl-resorcin, and he has obtained and examined dinitro-resorcin, mono-brom-dinitro-resorcin, diamido-resorcin hydrochlorate, and diimido-resorcin.

The Action of Bromine in Alkaline Solution upon the Amines.—A. W. Hofmann.—If the hydrochloric solution of a primary monamine of the aliphatic series is mixed with an alkaline solution of bromine, using, by preference, 1 mol. primary monamine, 2 mols. bromine, and a corresponding quantity of alkali, there are formed mono-alkalised nitro-bromides, containing 2 atoms of bromine.

A Convenient Preparation of the Paraffins.—B. Kœhnlein.—The author proposes a method for obtaining the hydrocarbons $C_n H_{2n+2}$, the homologues of methane. Pure anhydrous aluminium chloride was brought in contact in a tube with pure dry propyl-iodide, the liquid assumed a dark colour in the cold. After the air had been exhausted, and the tube had been heated for some hours to 130° to 140°, it was found to contain fine large crystals of iodine, a mobile liquid, and a gas, which was perfectly pure propan.

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Further Observations on Piperidine and Pyridine.—A. W. Hofmann.—Piperidine is readily converted into pyridine by means of bromine. The inverse transformation was attempted, but without success.

Behaviour of the Cyanic Compounds of the Three Isomeric Phenylen-diamines.—E. Lellmann.—The transition of phenylen-diamine-dicyanate into phenylen-diurea is the same for all the three isomers. The author gives an account of the preparation and properties of ortho-, meta-, and para-phenylen-diurea.

Nitro and Amido Derivatives of Benzol-sulph-anilide and Benzol-sulph-para-toluide.—E. Lellmann.—An account of benzol-sulph-ortho-nitranilide, the corresponding meta and para compounds, of benzol-sulph-meta-nitro-para-toluide, benzol-sulph-meta-dinitro-para-toluide, benzol-sulph-ortho-amido-anilide, and benzol-sulpho-metamido-para-toluid.

Theory of Phosphorescent Phenomena.—Br. Radziszewski.—The substances—several hundreds—which the author has examined, resolve themselves into two groups: 1. Such as become luminous on the addition of alkalies when they already contain active oxygen which is generated in them by the influence of some excitant, *e.g.*, sunshine; and, 2, such as on the addition of alkalies generate active oxygen and phosphoresce on combining therewith. To the first group belong various hydrocarbons, the terpenes, &c. Some of these bodies emit light when exactly neutralised with milk of lime, &c. They are beautifully luminous when heated with dry caustic alkali. To the second group belong aldehyds, or bodies which produce aldehyds on treatment with alkalies. These bodies, however, are not luminous in aqueous solutions. The author enters upon the question of the activation of oxygen, especially in the living organism.

Sulphuric Acid in Sherries.—E. Borgmann.—The author has analysed vineyard soil from the best sherry districts, and finds that it contains only 0·1578 per cent of sulphuric acid,—a proportion by no means abnormally high, and quite insufficient to account for the considerable percentage of sulphuric acid found in the sherry of commerce.

The Behaviour of Sulphuryl-chloride and of Chloro-sulphonic Acid at High Temperatures.—K. Heumann and P. Kœchlin.—At 184° the vapour-density of sulphuryl-chloride is still normal, the compound having undergone neither dissociation nor decomposition. At 442° the molecule is completely broken up. The vapour-density of chloro-sulphonic acid at 184° shows dissociation; at 442° the decomposition is complete.

Constitution of Nitroso-malonic Acid.—V. Meyer and A. Müller.—This memoir does not admit of useful abstraction.

Reduction of Substituted Phenols.—F. Pfaff.—The author attempts to obtain substituted resorcins of known constitution, examining their behaviour with phthalic acid. He has examined mono-brom-meta-nitro-phenol, studied its reduction, its methyl-ether and its reduction. He has also examined meta-anisidine, the salts of mono-brom-meta-nitro-phenol, and nitroxylenol.

Oxidising Action of Dilute Nitric Acid upon Meta-isobutyl-toluol.—W. Kelbe.—The author obtains by this reaction an acid which may be regarded either as meta-isobutyl-benzoic acid or as meta-tolyl-isobutyric acid. From petroleum ether it crystallises in fine needles, fusible at 91° to 92°. The solution in ammonia yields

with silver nitrate a white precipitate, very sparingly soluble in water.

The Displacement of the Sulpho-group by Chlorine.—W. Kelbe.—The author's researches refer to the elimination of the sulpho-group from cymol sulphuric acid by means of chlorine. The product of the reaction is tetra-chlor-cymol.

The Crystalline Form and Composition of Barium-para-toluol-sulphate.—W. Kelbe.—At temperatures above 30° this salt crystallises in anhydrous leaflets, but below 30°, in needles, with 3 mols. of crystalline water.

Action of Aluminium Bromide upon Symmetric Dibrom-ethylene and Benzol.—R. Anschütz.—The principal product of the reaction is dibenzyl, accompanied by a small quantity of anthracene.

A New Synthesis of Anthracene.—R. Anschütz and F. Eltzbacher.—The authors obtain anthracene from acetylene bromide and benzol under the influence of aluminium chloride.

Action of Zinc Chloride upon Camphor.—A. Reuter.—Not suitable for abstraction.

A Transposition by Means of the Anhydro-compound.—W. Böttcher.—The compound formed by anhydro-benzamido-phenol on taking up water is Hübner's benzamido-phenol.

Salt-formation of Symmetric Tribrom-aniline.—L. Gattermann.—The author has produced and examined symmetrical tribrom-aniline hydrobromate and hydrochlorate.

Action of Acetyl-chloride upon Benzaldehyd in Presence of Zinc Powder.—C. Paal.—An examination of the compound $C_9H_8O_2$, which the author had formerly obtained.

Derivatives of α-Naphthoeic Acid.—P. Bœssneck.—The author gives an account of the transformation of naphthoyl-chloride into α-naphthoyl-cyanide, of naphthoyl-formic acid, naphthyl-acetic acid, α-naphthyl-acetamide, α-naphthyl-aceto-nitril, and α-naphthyl ethenyl-diphenyl-diamine.

The Oxidation of Piperidine.—C. Schotten.—The author describes the preparation and properties of piperidic acid, nitro-dehydro-piperyl-urethan, the brom-hydroxyl derivative of the last-mentioned compound, piperyl-methyl-urethan, nitro-dehydro-piperyl-methyl-urethan, and the action of bromine upon piperyl-ethyl-urethan.

Triaceton-alkamine.—E. Fischer.—The author, with the view of testing the accuracy of the formula proposed by Heintz, endeavours to convert triaceton-alkamine by the abscission of water into an anoxygenous base of the piperidine series.

Phthalyl-acetacetic Ether.—E. Fischer and H. Koch.—This compound forms, when pure, colourless prisms, melting at 124°. On prolonged boiling with dilute sulphuric acid it is saponified with formation of phthalic acid.

Quinazol Compounds.—E. Fischer and Hans Kúzel. An account of nitroso-ethyl-ortho-amido-cinnamic acid, diethyl-ortho-amido-cinnamic acid, ethyl-quinazol-carbonic acid, and ethyl-quinazol.

A New Reaction of the Aldehyds.—F. Penzoldt and E. Fischer.—For the practical execution of the test it is best to employ pure crystalline sulpho-diazo-benzolic acid. It is fresh dissolved on each occasion in about 60 parts of cold water with a little soda-lye, the substance under examination, mixed with dilute alkali and a few granules of sodium amalgam, is added, and the whole is let stand quietly. If an aldehyd is present, there appears in ten to twenty minutes a reddish violet colour, resembling pure magenta. In oil of bitter almonds it can be distinctly recognised in the dilution of 1 : 3000. This test is much more sensitive than the well-known reaction with rosaniline sulphurous acid. It succeeds with all aldehyds which are permanent in alkaline solutions. It has been specially verified with acet-, valer-, œnanth-, and benz-aldehyd, furfurol, and glyoxal. Chloral and benzoine do not yield the reaction. Acetone and acetacetic ether yield, under the same circumstances, a deep red colour, but without the characteristic violet tone. The same applies to phenol, resorcin, pyro-catechin, if care be taken that they come in contact with the diazo compound only in presence of an excess of alkali.

Decomposition of Benziloid Bodies by Potassium Cyanide.—Fr. Jourdan.—The action of potassium cyanide is in this case evidently similar to that of a ferment, as it undergoes no change in the reaction, and as a very small proportion is sufficient for the transformation of considerable quantities of benzil.

Compounds of the Hydrazines with the Ketones.—H. Reisenegger.—An account of aceton-phenyl-hydrazin, aceto-phenon-phenyl-hydrazin, aceto-phenon-dimethyl-hydrazin, and of the behaviour of œnanthol with phenyl-hydrazin, and of the same substance with chloral.

Cosmos les Mondes.

No. 5, September 29, 1883.

Filtration of Finely-divided Precipitates.—Lecoq de Boisbaudran.—Already inserted.

Combination-calories of the Soluble Compounds of Cadmium.—Dr. D. Tommasi.—The author gives the combining-heats of cadmium bromide, iodide, nitrate, and sulphate, as calculated by the law of thermic substitution constants, and as actually found by experiment.

No. 6, October 6, 1883.

Copper and Microbia.—It is stated that the antiseptic action of copper sulphate is slightly superior to that of salicylic and benzoic acids; twice greater than that of phenol; five times greater than that of alum, tannin, and arsenious acid; and ten times greater than that of chloral hydrate and the ferrous salts. Copper chloride is from one-third to one-half more efficient than the sulphate.

No. 7, October 13, 1883.

The death is announced of M. Plateau, emeritus Professor of Physics at the University of Ghent.

MISCELLANEOUS.

Appointment.—Mr. W. C. Young, F.I.C., &c., Public Analyst for the Poplar and Whitechapel districts, has been appointed Public Analyst for the Parish of St. George in the East, Middlesex.

Laws governing the Action of Acids upon the Rotatory Power of Alkaloids.—A. C. Oudemans.—The specific rotatory power of the mono-acid bases observed in the form of neutral salts and in aqueous solution is constant for all salts, and is independent of the chemical nature of the acid; the slight differences observed depend on the decomposing action of the water.—*Journal de Pharmacie.*

MEETINGS FOR THE WEEK

MONDAY Nov. 19th.—Medical, 8.30.
TUESDAY, 20th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
WEDNESDAY, 21st.—Meteorological, 7.
—— Society of Arts, 8.
—— Geological, 8.
THURSDAY, 22nd.—Royal, 4.30.
—— Philosophical Club, 6.30.
FRIDAY, 23rd.—Quekett Club, 8.
SATURDAY, 24th.—Physical, 3. "On the Purification of Mercury by Distillation *in vacuo*," by J. W. Clark. "On the Measurement of the Curvature of Lenses, by Prof. R. B. Clifton, F.R.S.

THE CHEMICAL NEWS.

Vol. XLVIII. No. 1252.

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE, AND THE INFLUENCE OF CERTAIN REAGENTS EMPLOYED IN SEPARATING THE ACID FROM BASES.

By DAVID LINDO.

(Concluded from p. 231).

Precipitation of P_2O_5 in presence of ammonium citrate with slight and large excess of Mg Mix., and precipitating in presence of ammonium citrate, oxalate, and chloride with excess of reagent.

June, 1883. Series W.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution, 55 c.c. water, 20 c.c. No. 1 NH_3, and 1 grm. citric acid. Other conditions same as tests.

Six Experiments.—In each proceeded as above, except that only 0·5 gramme citric acid was used.

Six Tests.—Modified, *i.e.*, NH_3 before precipitation.

No. of Expt.	1 gramme Citric Acid. 12 c.c. Mg Mix. No. 1.	No. of Expt.	0·5 gramme Citric Acid. 12 c.c. Mg Mix. No. 1.	No. of Expt.	Tests Modified.
W 338	98·30	W 344	99·15	W 350	99·95
339	98·65	345	99·30	351	99·80
340	98·35	346	99·20	352	99·85
341	98·05	347	99·25	353	99·75
342	98·20	348	99·25	354	99·80
343	98·35	349	99·10	355	99·90
Average	98·32	Average	99·21	Average	99·84

The precipitates with citric acid were as white as the tests. Four of them were ignited over the blast; they lost no more weight than the tests as previously determined.

June, 1883. Series X.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 45 c.c. water, 30 c.c. No. 1 NH_3, 2 grms. citric acid, 15 c.c. Mg mixture No. 1.

Six Experiments.—In each, proceeded as above, except that 33 c.c. Mg mixture No. 1 were used.

Six Tests.—Modified as usual, and corrected for blast.

The precipitates after ignition over the Berzelius lamp were dark, Four experiments showed that they lost more weight than the tests. I have corrected the results from the average loss so found, but in all experiments with citric acid made after these, *each* precipitate was ignited over the blast.

No. of Expt.	2 grms. Citric Acid. 15 c.c. Mg Mix. No. 1. Corrected for Blast.	No. of Expt.	2 grms. Citric Acid. 33 c.c. Mg Mix. No. 1. Corrected for Blast.	No. of Expt.	Tests Modified and corrected for Blast.
X 356	98·65	X 362	99·05	X 368	99·91
357	98·50	363	99·25	369	99·76
358	98·15	364	99·65	370	99 91
359	98·10	365	99·40	371	99·86
360	98·55	366	99·45	372	99·71
361	98·40	367	99·50	373	99·81
Average	98·39	Average	99·38	Average	99·83

July, 1883. Series Y.—Solution from the salt bruised and mixed, April, 1883. Mg Mixture from burette.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3 1 gramme citric acid, 33 c.c. Mg Mix. No. 1. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each proceeded as above, but in addition added 2 grammes NH_4Cl and 0·25 gramme $NH_4O,\overline{O}$.

Six Tests.—Modified, and corrected for blast.

No. of Expt.	1 grm. Citric Acid. 33 c.c. Mg Mix. No. 1.	No. of Expt.	1 grm. Citric Acid; 2 grms. NH_4Cl; 0·25 grm $NH_4O,\overline{O}$; 33 c.c. Mg Mix. No. 1.	No. of Expt.	Tests Modified and corrected for Blast.
Y 374	99·40	Y 380	99·05	Y 386	99·71
375	99·65	381	99·25	387	99·71
376	99·20	382	99·45	388	99·76
377	99·60	383	99·35	389	99·76
378	99·30	384	99·25	390	99·91
379	99·75	385	99·35	391	99·86
Average	99·48	Average	99·28	Average	99·79

August, 1883. Series Z.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—In each, added to the 25 c.c. micro. solution 55 c.c. water, 20 c.c. No. 1 NH_3, 2 grammes citric acid, 15 c.c. Mg Mixture No. 1 from burette. Let settle, then added 25 c.c. Mg mixture No. 2 from the measure 4 or 5 c.c. at a time, stirring well after each addition. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each, proceeded as above, except that at the end added 50 instead of 25 c.c. Mg mixture No. 2 from the measure, about 10 c.c. at a time.

Six Tests.—Corrected for the blast. Mg mixture from burette.

No. of Expt.	2 grms. Citric Acid; 15 c.c. Mg Mix. No. 1; 25 c.c. Mg Mix. No. 2.	No. of Expt.	2 grms. Citric Acid; 15 c.c. Mg Mix. No. 1; 50 c.c. Mg Mix. No. 2.	No. of Expt.	Tests corrected for Blast.
Z 392	99·50	Z 398	99·80	Z 404	100·01
393	99·65	399	99·75	405	100·01
394	99·80	400	100·00	406	99·96
395	99·95	401	99·90	407	99·96
396	99·60	402	99·90	408	100·06
397	99·80	403	99·90	409	100·01
Average	99·72	Average	99·88	Average	100·00

Solvent action of ammonium citrate on the precipitate, and the influence of Mg Mixture in counteracting this.

June, 1883.—Series A A.—Solution from the salt bruised and mixed, April, 1883. Mg Mix. from burette.

Six Experiments.—In each, washed the precipitate with 100 c.c. of solution composed of 2 grms. citric acid, 80 c.c. water, and 20 c.c. No. 1 NH_3.* Then washed with 100 c.c. No. 3 NH_3. Other conditions same as tests.†

* The NH_3 is in considerable excess of the quantity required to neutralise the 2 grammes citric acid.

† The 100 c.c. No. 3 NH_3 with which the precipitate was finally washed were found sufficient, but for strict comparison with the tests and for other reasons, the method adopted in testing the solvent action of ammonium oxalate and chloride, viz., to wash the precipitate first with 50 c.c. No. 3 NH_3, then with the solvent, and finally with 150 c.c. No. 3 NH_3, would have been preferable. It would also have been better to use No. 2 Mg mixture instead of No. 1. These experiments on the solvent action of ammonium citrate were made, as the dates will show, previous to those on the solvent action of the other reagents already referred to.

Six Experiments.—In each, proceeded as above, except that to the solution containing 2 grammes citric acid I added 20 c.c. No. 1 Mg Mixture.

Six Tests.

No. of Expt.	Washed with solution contg. 2 grms. Citric Acid.	No. of Expt.	Washed with solution contg. 2 grms. Citric Acid and 20 c.c. Mg Mix. No. 1.	No. of Expt.	Tests.
A A 410	92·55	A A 416	99·90	A A 422	100·00
411	92·70	417	99·85	423	100·10
412	92·70	418	100·00	424	99·90
413	92·95	419	99·95	425	100·10
414	92·55	420	99·95	426	99·95
415	92·60	421	100 10	427	100·00
Average	92·67	Average	99·96	Average	100·01

*recipitation of P_2O_5 in presence of ammonium citrate, oxalate, and chloride; ferric oxide and alumina with large excess of Mg Mixture.**

August, 1883. Series B B.—Solution from the salt bruised and mixed, April, 1883.

Six Experiments.—Used in each:—
25 c.c. micro. solution.
50 c.c. water.
10 c.c. solution ferric chloride = 0·0322 grm, Fe_2O_3.
10 c.c. solution aluminium chloride = 0·0225 grm. Al_2O_3.
2 grammes citric Acid.
20 c.c. No. 1 NH_3.
0·5 gramme $NH_4O,\overline{O}$.
15 c.c. Mg mixture No. 1 from burette.
50 c.c. Mg mixture No. 2, 10 c.c. at a time from the measure.
Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each, proceeded as above, except that 0·25 gramme only of $NH_4O,\overline{O}$ was introduced.

Six Tests.—Corrected for blast. Mg Mix. from burette.

No. of Experiment.	2 grammes citric acid I. 0·5 gramme $NH_4O,\overline{O}$. 0·0322 gramme Fe_2O_3. 0·0225 gramme Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid. I. 0·25 grm. $NH_4O,\overline{O}$. 0·0322 grm. Fe_2O_3. 0·0225 grm. Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
B B 428	99·90	B B 434	100·10	B B 440	99·71
429	100·05	435	100·20	441	99·81
430	100·20	436	99·55	442	100·01
431	100·45	437	100·35	443	99·91
432	99·85	438	99·95	444	99·96
433	98·85	439	100·15	445	100·11
Average	100·05	Average	100·05	Average	99·92

September, 1883. Series C C.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Six Experiments.—Proceeded in each exactly as in Nos. 428 to 433 except that *all* the Mg mixture was delivered from burette in drops.

Six Experiments.—Proceeded as above, except that half the quantity of metallic oxides was employed.

Six Tests.—Corrected for the blast.

No. of Experiment.	2 grammes citric acid I. 0·5 gramme $NH_4O,\overline{O}$. 0·0322 gramme Fe_2O_3. 0·0225 gramme Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid I. 0·5 gramme $NH_4O,\overline{O}$. 0·0161 gramme Fe_2O_3. 0·0112 gramme Al_2O_3. 15 c.c Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
C C 446	99·55	C C 452	100·00	C C 458	99·96
447	100·30	453	100·00	459	99·91
448	100·15	454	99 60	460	100·11
449	100·00	455	99·85	461	99·91
450	100·20	456	100·15	462	99·96
451	99·85	457	100·00	463	99·96
Average	100·01	Average	99·93	Average	99·97

Precipitation of P_2O_5 in presence of ammonium citrate, oxalate, sulphate, and chloride; ferric oxide and alumina, with large excess of Mg Mixture.

September, 1883. Series D D.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Six Experiments.—Used in each, 25 c.c. micro. solution, 55 c.c. water, 10 c.c. sol. ferric chloride, 10 c.c. sol. alumina chloride, 2 grms. citric acid, 0·5 grm. $NH_4O,\overline{O}$, 0·25 grm. NH_4O,SO_3, 20 c.c. No. 1 NH_3, 15 c.c. Mg mixture No. 1, 50 c.c. Mg mixture No. 2. Ignited first over Berzelius lamp, then over blast.

Six Experiments.—In each proceeded as above, except that 1 grm. $NH_4O,\overline{O}$ was introduced instead of 0·5 grm.

Six Tests.—Corrected for the blast.

No. of Experiment.	2 grammes citric acid. I. 0·5 gramme $NH_4O,\overline{O}$. 0·25 grm. NH_4O,SO_3. 0·0322 grm. Fe_2O_3. 0·0225 grm. Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	2 grammes citric acid. I. 1 gramme $NH_4O,\overline{O}$. 0·25 grm. NH_4O,SO_3. 0·0322 grm. Fe_2O_3. 0·0225 grm. Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
D D 464	100·40	D D 470	100·35	D D 476	100·06
465	100·15	471	100·35	477	100·06
466	100·15	472	100·10	478	99·91
467	100·25	473	100·20	479	99·91
468	99·90	474	100·20	480	99·96
469	100·40	475	100·50	481	100 06
Average	100·21	Average	100·28	Average	99·99

September, 1883.—Series E E.—Solution from the salt bruised and mixed, April, 1883. All the Mg mixture from burette.

Three Experiments.—In each, proceeded as in 464 to 469 as far as precipitating with 50 c.c. No. 2 Mg mixture; then, after allowing the usual time, instead of filtering through the Gooch crucible, I filtered through purified Swedish paper. Washed with 50 c.c. No. 3 NH_3, dissolved in 10 c.c. 6 per cent HCl. Added 0·030 grm. citric acid, then very gradually (to solution made up to about 100 c.c.) 20 c.c. No. 1 NH_3; let settle. Added 30 c.c. No. 2 Mg Mix. After some hours filtered through the Gooch, and washed with 150 c.c. No. 3 NH_3. Ignited first over Berzelius lamp, and then over blast.

Three Experiments.—In each, proceeded as in 470 to 475 as far as precipitating with 50 c.c. No. 2 Mg mixture. Then washed, dissolved, re-precipitated, and proceeded otherwise as above.

Three Tests.—Corrected for blast.

* Except the NH_4Cl in Mg mixture none was actually introduced, but 0·3419 gramme, it may be supposed, will be formed from the Cl in the 20 c.c. metallic solutions used.

No. of Experiment.	*Re-precipitated.* 2 grms. citric acid. 0·5 gramme $NH_4O.O.SO_3$. 0·25 grm. $NH_4O.SO_3$. 0·0322 grm. Fe_2O_3. 0·0225 grm. Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	*Re-precipitated.* 2 grms. citric acid. 1 gramme $NH_4O.O.SO_3$. 0·25 grm. $NH_4O.SO_3$. 0·0322 grm. Fe_2O_3. 0·0225 grm. Al_2O_3. 15 c.c. Mg Mix. No. 1. 50 c.c. Mg Mix. No. 2.	No. of Experiment.	Tests corrected for Blast.
E	E	E	E	E	E
482	99·90	485	99·95	488	99·76
483	100·00	486	99·80	489	99·91
484	99·90	487	99·85	490	99·86
Average	99·93	Average	99·87	Average	99·84

REMARKS AND CONCLUSIONS.

Influence of Heat.

Experiments (Series E) have shown that when the solution is moderately heated the results are as accurate as in the cold, but previous experiments had shown that if the solution is kept at or near the boiling-point during precipitation the results will be too high. In my experiments the error was about 0·5 per cent. In the presence of ammonium oxalate the error would probably be increased.

Effect of adding Excess of Mg Mixture.

Experiments have shown that *large* excess added *gradually* never does *harm*,* and that it is *essential* to use a large excess in the presence of ammonium chloride, oxalate, and citrate, especially the two latter, but even moderate excess added all at once makes the results too high (Series F).

Method of adding the Mg Mixture.

From a burette, a drop a second with constant stirring as recommended by Gladding is the best method, yet experiments, Series G, have shown the results will be nearly as accurate if the reagent is added about 2 c.c. at a time, stirring well after each addition.

Effect of Concentration.

When 20 c.c. No. 1 Mg Mixture were added all at once to a concentrated solution (Series G), the results were a little too high, though rather less so than when 15 c.c. were added in the same manner to a solution diluted as usual, Series F. When 12 c.c. No. 1 Mg Mix. were added one drop a second to a concentrated solution (Series H and I), the results were slightly below the truth. This is due to the NH_3 in the Mg mixture acting with more effect in the concentrated solution.† When the same quantity and strength of *neutral* Mg mixture was added in the same way to a concentrated solution, the results were accurate, Series L. It must be borne in mind no extraneous reagents, such as ammonium oxalate, &c., were introduced in these experiments.

Effect of Precipitating with Neutral Mg Mixture.

The precipitation in this case is not complete until ammonia is added, which should be very dilute, and delivered preferably from a burette a drop at a time with constant stirring. The precipitate is highly crystalline, occupies little space, and is washed very rapidly by suction. The results are accurate. Series K.

Influence of Ammonia.

If the precipitation takes place in the presence of much free ammonia, the precipitate will be in great part almost amorphous, very voluminous, and tedious to wash by suction; unless such salts as ammonium citrate and oxalate (or even chloride in considerable quantity) are also present, when the precipitate will be highly crystalline, and occupy little space even if the solution contains much free ammonia. A highly crystalline precipitate is washed very rapidly by suction, and appears less soluble than the other form; but as the dilute ammonia in passing once through the precipitate is probably never saturated with it, and the less so the more rapid the washing, the lower results obtained with bulky precipitates may be partly at least due to longer contact with the fixed volume of dilute ammonia employed to wash with. Adding 10 c.c. No. 1 NH_3 before precipitating generally gave results a little lower than were obtained when it was added after.* When the precipitation was made in a solution containing 85 c.c., 11·54 per cent NH_3, the total volume being 110 c.c., 99·63 per cent was obtained, the tests averaging 100·04. Series P.

Solvent Action of Dilute Ammonia on the Precipitate.

I have elsewhere remarked that the dilute ammonia in passing once through the precipitate is probably never saturated with it. For the purposes of this enquiry it is necessary to ascertain the solvent action under the conditions of the experiment. It has been shown this will vary according to the state of the precipitate. I made several experiments to ascertain if a highly crystalline precipitate, such as will be obtained by precipitating in presence of certain salts, or by using neutral Mg mixture, is less soluble than the more voluminous one obtained in the test experiments (not modified), where Mg mixture containing free NH_3 was used; but, washing with 200 c.c., the difference, if any, was too small for measurement. As in practice a very voluminous precipitate will rarely be obtained, I have confined the experiments given here to precipitates derived from the tests, not modified.

The precipitates (Series Q) washed with 200 c.c. No. 2 NH_3, gave 100·04, and those washed with 600 c.c., 99·62. Series R experiments repeated gave practically the same results. The difference 0·42 per cent would represent the solvent action of 400 c.c. No. 2 NH_3, which, on a precipitate of $Mg_2P_2O_7$ weighing 0·2 grm., would amount to 0·00084 grm. 1 litre of No. 2 NH_3 would therefore dissolve an amount of the precipitate equal to 0·0021 grm. $Mg_2P_2O_7$, and 3 litres, 0·0063 grm. As a control to the above, 3 litres of the washings with No. 2 NH_3 (collected in a clean receiver) were evaporated to small volume in a porcelain dish, transferred to a smaller dish, evaporated with addition of pure nitric acid to dryness on the water-bath, alternately moistened with nitric acid and evaporated to dryness several times; added a little nitric acid and water, heated, and passed through a small purified filter. Precipitated with molybdic reagent, and proceeded according to recent improvements in the method to recover the P_2O_5 as $Mg_2P_2O_7$. It weighed 0·0066 grm.† 3 litres of washings with No. 2 NH_3 from Series R treated in the same way, gave 0·007 grm. $Mg_2P_2O_7$, average 0·0068 grm., which is 0·0005 grm. excess of the calculated results. I am inclined to place most reliance on the latter, for, although the washings were evaporated in a tranquil atmosphere, the experiments would have been more reliable if the evaporation had been conducted as in a water analysis. Experiments were made in the same way on the solvent action of No. 3 NH_3. The results calculated from two series of experiments showed 3 litres would dissolve = 0·0086 grm. $Mg_2P_2O_7$. The actual quantity recovered from 3 litres was 0·009 grm. The rule in washing with No. 2 NH_3 would be to add 0·0002 grm. to the weight of the precipitate for every 100 c.c. used. If 200 c.c. are used, and the precipitate should weigh 0·2 grm., omitting to make the correction would cause a minus error of 0·2 per cent.‡ In washing with No. 3 NH_3 we should have to add 0·0003 grm. (nearly) to the weight of

* Except in presence of ammonium sulphate; and when the conditions, of which a summary is given further on, are observed.

† This will be explained under remarks on the influence of NH_3.

* When the tests so modified were not slightly below the truth there can be little doubt the salt had lost water of crystallisation.

† A blank experiment made by evaporating 1 litre of the dilute NH_3 (equal in strength to 3 litres No. 2) to dryness, and testing after treating as above for P_2O_5 with molybdic reagent, led to a negative result.

‡ If Mg mixture has been added in sufficient quantity the mother-liquor will have no solvent action on the precipitate.

the precipitate for every 100 c.c. employed. Using 200 c.c. and omitting the correction would cause a minus error of 0·3 per cent with precipitates weighing as above. The results of experiments made in the course of this enquiry seem to show the precipitate is seldom obtained so pure as to warrant the full correction, but, as observed before, it is difficult to settle the point definitely by work done with a salt containing water of crystallisation.* I may here state that 100 c.c. were often found sufficient to wash a precipitate weighing after ignition 0·2 grm., while in other cases nearly 200 c.c. were consumed before the chlorine reaction disappeared; to be sure of thorough washing without testing in every experiment I always used 200 c.c.

Precipitation of P_2O_5 in Presence of Ammonium Chloride, Oxalate, and Citrate.

The influence of these salts in lowering the results has been sufficiently shown in the course of this enquiry. I believe it has generally been considered that the effect is entirely due to their solvent action on the precipitate, but the oxalate and citrate (if not the chloride) seem to hinder to some extent the reaction that determines the formation of ammonio-magnesian phosphate, for the quantity of Mg mixture that will counteract the solvent action of a given quantity of oxalate or citrate on the precipitate already formed, will not, if used as excess, precipitate all the P_2O_5 in presence of a similar quantity of oxalate or citrate, the volumes of the solutions in both cases being the same.

Mg mixture used in large excess in precipitating in presence of these salts seems to act in two ways; it counteracts the solvent action of the salts on the precipitate, and apparently by its mass overcomes, or nearly does so, the resistance which the salts in question seem to offer to the completion of the reaction. The effect of excess of Mg mixture has been considered very different by others; although its influence in counteracting the solvent action of NH_4Cl is well known, its influence in this respect (and in the other referred to) in the case of oxalate and citrate, seems to have been overlooked or ignored. It has been held that in the presence of these salts, large excess of Mg mixture will, as a rule, lead to high results from magnesium oxalate and citrate being thrown down, and that accurate results will only be obtained by accident.

In the presence of 0·5 grm. ammonium oxalate, using enormous excess of Mg mixture led to results slightly lower than the tests, Series U. In the presence of 2 grms. citric acid, using the same excess of Mg mixture gave results also slightly lower than the tests, Series Z. There is therefore no evidence whatever to show that excess of Mg mixture acts in the manner ascribed to it in the presence of such quantities of ammonium oxalate and citrate, as with ordinary care need never be exceeded in analysis, and in solutions sufficiently diluted.

The Solvent Action of Ammonium Chloride, Oxalate, and Citrate on the Precipitate.

When a solution composed of 100 c.c. water, 10 c.c. No. 1 NH_3, and 6 grms. NH_4Cl was sucked through the precipitate, the quantity of the latter dissolved was equal to 0·0029 grm. $Mg_2P_2O_7$, making the results 98·62, the tests giving 100·06. When 20 c.c. No. 2 Mg mixture were added (and probably less would have done) to the solution of NH_4Cl, the precipitate proved absolutely insoluble in the mixture, Series J. 1 grm. ammonium oxalate in 110 c.c. water and NH_3 dissolved = 0·0061 grm. $Mg_2P_2O_7$, giving 96·96. Tests 99·99, 20 c.c. No. 2 Mg mixture, rendered the solution of ammonium oxalate totally without solvent action, Series V. On reference to Series S, it will be seen that 1 c.c. No. 1 Mg mixture in excess of the quantity required (11 c.c.) for exact precipitation, sufficed to reduce the error greatly when the P_2O_5 was precipitated in presence of 1 grm. ammonium oxalate, the result being 99·31, tests 100·04, yet the enormous excess of reagent used in presence of 0·5 grm. oxalate failed to give results quite as high as the tests, Series U.

Washing with solution containing 2 grms. citric acid and excess of NH_3 dissolved = 0·0147 grm. $Mg_2P_2O_7$ giving 92·67, tests 100·01, 20 c.c. Mg mixture No. 1 added to the solution of citric acid, rendered the solvent action little more than the dilute ammonia No. 3, Series AA. Here, again, on reference to Series X it will be seen how small an excess of Mg mixture used in precipitating in presence of 2 grms. citric acid reduced the error enormously, the results being 98·39 with 15 c.c. Mg mixture, tests 99·83.

The conclusion I arrive at from results obtained in the course of this investigation, is that the separation of P_2O_5 by the oxalic acid method will, if the process is conducted with the simple precautions indicated in this paper, be very nearly if not quite as accurately effected as by the molybdic method, even in the presence of considerable quantities of ferric oxide and alumina.

The rule is to use only moderate excess of ammonium oxalate in precipitating the lime; to use citric acid pretty freely in presence of the metallic oxides; to precipitate first with a rather weak Mg mixture, using some excess, and delivering from a burette in the manner described. Let the precipitate settle, then add a large volume of stronger Mg mixture, preferably delivered also from a burette in drops, with constant stirring. In the presence of a moderate amount of ammonium sulphate, there will be a slight plus error; if more accurate results are desired they can be obtained by a second precipitation; except in the presence of sulphate this will be quite unnecessary.

Notes.

Precipitates obtained in test experiments contracted greatly on ignition, and split in rings.

Highly crystalline precipitates occupying little space, obtained by precipitating in presence of certain salts or with neutral Mg mixture, were much more bulky after ignition than the tests, and formed a porous mass. In presence of much citric acid they were very dark after ignition over the lamp, but a few minutes' exposure to the blast rendered them perfectly white. The loss, however, rarely amounted to 1 milligrm., and averaged about 0·0006 grm.

The following experiments illustrate that in mixing citric acid solutions of ferric chloride and ammonia together, there will be a striking difference in the results according to the order in which they are are mixed.

Solutions used.

Citric acid; 50 c.c. contained 0·5 grm. acid.

Ferric chloride containing some excess of HCl; 10 c.c. gave 0·035 grm. ferric oxide.

No. 1 NH_3 containing 6·34 per cent.

Micro-solution, as in former experiments.

Mg mixture No. 1.

The reagents were mixed in the order given below:—

Experiment 1.

5 c.c. solution ferric chloride.

50 c.c. citric acid solution; colour of mixture, bright yellow.

10 c.c. No. 1 NH_3; colour changed to *light yellowish green*.

20 c.c. micro-solution.

11 c.c. No. 1 Mg mixture (burette) precipitate fell white or practically so.

Experiment 2.

50 c.c. citric acid solution.

10 c.c. No. 1 NH_3.

5 c.c. solution ferric chloride; *colour of mixture, orange.*

20 c.c. micro-solution.

* The lower results obtained with very voluminous precipitates were due to greater solvent action in washing, and not to greater purity, as was proved by recovering the P_2O_5 from some of the washings.

11 c.c. No. 1 Mg mixture (burette) precipitate fell *deeply stained with ferric oxide.*

Experiment 3.

Mixed the three first reagents again in the two different orders given above, and heated to the boil. No change of colour in either.

These experiments show the ammonia should always be added after the citric acid and iron, which in analysis is always done, though the effect of doing the reverse does not seem to have been noticed before.

Falmouth, Jamaica, B.W.I.,
October 2, 1883.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING OCTOBER 31ST, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, November 6th, 1883.

SIR,—We submit herewith the results of our analyses of the 189 samples of water collected by us during the past month, at the times and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from October 1st to October 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples taken for analysis.

The Chelsea Company's water, as delivered from the stand-pipe opposite the Horse Guards, was, during the first week of the month, slighly turbid from the presence in suspension of a small quantity of mineral matter. The turbidity was enquired into by us, and was found to be confined to that locality, and to be dependent on certain works in connection with the water supply of the neighbourhood, rendered necessary by the erection of new buildings.

Excluding the first week of the Chelsea Company's supply, at the Horse Guards, the 181 samples of water submitted to examination, were, with the exception of three samples recorded as "very slightly turbid," clear, bright, and well filtered.

The water supplied to the metropolis throughout the entire month has been of most excellent quality.

With respect to the frequently considerable variations with season, in the always small amount of organic matter, met with in London water, it results from our experiments that the mean amount of organic carbon in the water furnished during October by the Companies taking their supply exclusively from the Thames, was just 0·100 part in 100,000 parts of the water, the average amount for the past six months having been 0·116 part, corresponding to about 2-10ths of a grain of organic matter per gallon. With the coming on, however, of winter, the low amounts of organic carbon, and consequently of organic matter, present in the water for so many months past, can scarcely any longer be expected.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

DETERMINATION OF THE EQUIVALENTS OF COPPER AND ZINC BY MEANS OF THEIR SULPHATES.

By M. H. BAUBIGNY.

THANKS to the beautiful and classic researches of M. Stas on the reciprocal relations of the atomic weights of certain simple bodies, we now possess all the elements necessary for calculating with great precision, by the aid of experimental data, the atomic weights of other bodies, and for comparing the results obtained by the different methods employed.

Among the numbers important to be known, only the proportion of the atomic weights of oxygen and hydrogen has not been determined with a sufficient exactitude, notwithstanding the researches of the most eminent *savants* who have occupied themselves with this subject.

To avoid prolonging the calculation and to render it independent of the cause of error attached to the uncertainty which exists on the value of this proportion, represented at present by 7·98, if H = 1, the author takes as a basis O = 8. By operating thus the equivalents of the metals will depend only on the proportion of the equivalents of oxygen and sulphur, since his determinations have been made by means of an anhydrous sulphate and in the state of a simple salt.

M. Stas has established the proportion of the equivalents of oxygen and sulphur with extreme care, and the author, with him, takes S = 16·037. For comparison with older determinations he proposes each time to calculate the equivalent of the metal as a function of the two numbers O = 8 and S = 16.

Copper.—The sulphate is prepared by dissolving in sulphuric acid, either the metal, or artificial atacamite, all these bodies being as pure as possible. When the solution in sulphuric acid is effected, the excess of acid is evaporated away, the salt taken up in water, filtered, and let crystallise. The decanted mother-liquor is again evaporated to crystallisation, and finally the mother-liquors of this second crystallisation are evaporated to dryness, yielding the product which the author calls evaporation-residues. If the salt is pure the same number should be found for the atomic weight of copper with the sulphate of the first crystallisation and with that of the residues.

a. A portion of the first crystallisation, after exposure to 440° for three hours, weighed 4·022 grms. The weight remained constant on heating anew for ten hours. It was calcined at the temperature of melting gold, the process being twice repeated; there remains copper oxide = 2·0035 grms.; loss (SO_3) = 2·0185 grms., whence the equivalent Cu = 31·739 if S = 16·037, and Cu = 31·703 if S = 16.

b. On operating in the same manner with a part of the evaporation-residues we have—Cu = 31·739 if S = 16·037, and Cu = 31·693 if S = 16; for 2·596 of sulphate left on calcination 1·293 CuO. As a mean we have, for S = 16·037, Cu = 31·734, and for S = 16, Cu = 31 698.

Berzelius, on reducing copper oxide by hydrogen, found 31·65; Erdmann and Marchand, by the same method, 31·728; M. Dumas, guided by the hypothesis of Prout, concluded from his observations that Cu = 31·75.

The unpublished experiments of M. Debray prove that cupric oxide is dissociated at high temperatures, and is transformed into cuprous oxide with dissociation-tensions fixed at each temperature, and that inversely if cuprous

oxide is allowed to cool in presence of oxygen, the re-transformation is entirely effected much above 440°. The author's results are, therefore, independent of this phenomenon of dissociation.

Zinc.—The sulphate is prepared by dissolving distilled zinc in pure dilute sulphuric acid, taking care that a part of the metal is left undissolved. The liquid is filtered, evaporated to dryness, and raised slowly to 440° in order to expel the excess of acid; then about 150 grms. of the sulphate are dissolved in 10 litres distilled water; a little of the zinc is precipitated by hydrogen sulphide, the vessel is closed, and the whole is allowed to stand for twenty-four hours, shaking from time to time. This zinc sulphide reacting upon the traces of the more sulphurable metals (lead, cadmium, &c.), which may be present, precipitates them. They are filtered off, and the filtrate is saturated with sulphuretted hydrogen, which precipitates the zinc almost entirely. This sulphide, washed several times with water slightly acidulated with sulphuric acid, and then dissolved in the concentrated acid, furnishes the zinc sulphate used in the author's determinations.

The salt dried at 440° was divided into three parts by fractional crystallisations, exactly as in the case of copper, the first portion and the residues being operated upon.

a. A part of the first crystallisation after exposure for seven hours to 440°, weighed 6·699 grms. The weight did not vary on re-heating for eight hours. It was calcined at the melting-point of gold, repeating the process twice: there remained $ZnO = 3·377$ grms., loss $(SO_3) = 3·322$ grms., whence the equivalent $Zn = 32·700$ if $S = 16·037$, and $Zn = 32·662$ if $S = 16$.

b. On operating in the same manner with a part of the evaporation-residues, we have—$Zn = 32·708$ if $S = 16·037$, and $Zn = 32·671$ if $S = 16$; for 8·776 grms. sulphate left 4·4245 zinc oxide. But as this oxide is absolutely fixed in the air at the temperature of melting gold, as appears from the researches of H. Sainte-Claire Deville, we are justified in assuming, as the mean of the above results,—$Zn = 32·704$ if $S = 16·037$, and $Zn = 32·667$ if $S = 16$.

Berzelius and Gay-Lussac, by the oxidation of zinc, came at first to the number 32·776, which they afterwards corrected to 32·258. Pelouze deduced the equivalent 32·5 from the anhydrous lactate. Marchand, by calcining the nitrate of a known weight of zinc, inferred, from the weight of the residual oxide, 32·55; whilst Favre, by the calcination of the oxalate, and Jacquelain, by the calcination of the sulphate, found the number 33.—*Comptes Rendus*, October 22, 1883.

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, November 15, 1883.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following certificates were read for the first time:—W. P. Bloxam, G. C. Chambers, A. Cobb, A. E. Ekins, F. P. Haviland, W. H. R. Kerry, F. Keeling, J. J. Pilley, J. Phillips, M. Percy, A. W. Rogers, A. Smithells, W. J. Saint, G. Smith. It was announced that a ballot would take place at the next meeting, December 6.

Mr. C. O'Sullivan then read a paper on the "*Estimation of Starch.*" The author has used the method described below during the last eight to ten years for estimating starch in cereals and malted grain. The method may be briefly described as follows:—The finely ground grain is successively extracted with ether, alcohol (sp. gr. 0·90), and water at 35° to 38°. The starch in the washed residue is gelatinised by boiling with water, cooled to 63°, and converted by diastase into dextrin and maltose. If a quantitative determination of these two products be made, the starch originally present can be calculated. The author describes the method as follows:—About 5 grms. of the finely-ground flour are introduced into a wide-necked 100 c.c. flask, and just saturated with alcohol, sp. gr. 0·82; 20 to 25 c.c. of ether are added. After standing several hours with occasional shaking, the ethereal solution is decanted through a filter, and the residue in the flask washed with ether. To the residue 80 to 90 c.c. of alcohol, sp. gr. 0·90, are added, and the mixture warmed to 35° to 38° for a few hours; the alcoholic solution is then decanted through the same filter, and the residue washed with alcohol, sp. gr. 0·90, at 35° to 38°. The residue in the flask and on the filter is washed into a 500 c.c. beaker, and the beaker filled with water. In about twenty-four hours the solution is decanted through a filter, and the residue washed with water at 35° to 38°. The residue in the beaker and on the filter is washed, with a short camel-hair brush and a fine jet, into 100 c.c. beaker. The whole is then boiled for a few minutes in the water-bath, with constant stirring, to gelatinise the starch; the beaker and its contents are cooled to 62° to 63°, and about 0·03 grm. of diastase added; the digestion at 62° is continued for an hour. The beaker is then boiled for eight to ten minutes, the solution filtered into a 100 c.c. measuring flask, the residue carefully washed with successive small quantities of boiling water, and the whole made up to 100 c.c. at 15·5°. The ether frees the grains from fat, &c.; the alcohol (0·90) removes the sugars, albumenoids other than casein, &c., whilst water at 35° to 38° dissolves out the amylams. Dextrin and maltose are the sole products of the action of diastase on starch. The diastase is prepared as follows:—2 to 3 kilos. of finely-ground pale barley malt are mixed with sufficient water to saturate and cover the whole. After standing three or four hours the mass is squeezed with a filter-press. If not bright the liquid is filtered. To the clear solution, alcohol, sp. gr. 0·83, is added as long as a flocculent precipitate falls; as soon as the supernatant liquid becomes milky, the addition of alcohol is discontinued. The precipitate is washed with alcohol, 0·86 to 0·88, dehydrated with absolute alcohol, pressed, and dried *in vacuo* over sulphuric acid until its weight is constant. Diastase thus prepared is a white, friable, easily soluble powder, which retains its activity for a considerable time. 5 grms. of barley flour thus treated with 0·03 grm. diastase gave 100 c.c. at 15·5°, having sp. gr. 1·01003, which represents 25·39 grms. solid matter (taking 1·00395 as the sp. gr. of a solution containing 1 per cent of starch products). 9·178 grms. of this solution reduced 0·241 grm. cupric oxide, and 200 m.m. of it gave a deviation in the Soleil Wentzke-Scheibler saccharimeter of 21·1 divisions. Thus we have $0·241 \text{ grm.} \times 0·7256 = 0·1748$ grm. maltose in 9·178 grms; in the 100 c.c., or 101·003 grms., there are 1·923 grms. maltose; 1 grm. of maltose in 100 c.c. gives a deviation in 200 m.m. of 8·02 divisions, and 1 grm. of dextrin in 100 c.c. gives 11·56 divisions. So $1·923 \times 8·02 = 15·422$, the optical activity of the maltose; and $21·1 - 15·422 = 5·678$, the optical activity of the dextrin. Therefore, in 100 c.c., there are—

$$\frac{5·678}{11·56} = 0·491 \text{ grm. of dextrin.}$$

We have, therefore, in the 100 c.c., maltose 1·923 grms., dextrin 0·491 grm., diastase 0·03 grm., = 2·444 grms. out of 2·539 solids, as indicated by the sp. gr. Of this deficiency of 0·095 grm. 0·083 proved to be α-amylam which had not been washed out. 1 part of starch yields 1 part of dextrin, and 1 part of starch yields 1·055 maltose. The starch represented by the above numbers is, therefore,—

$$\text{Dextrin} = 0·491,$$

$$\text{Maltose } \frac{1·928}{1·055} = 1·822,$$

or a total of 2·313 grms. starch from 5 grms. of barley. Barley thus contains 46·26 per cent of starch; a second experiment gave 46·38 per cent. The author gives many

other determinations in detail. Barley malt contains 39·9 per cent; wheat, 55·4; wheat malt, 43·26 and 43·53; Rye, 44 to 46; Rice, 75 to 77; maize, 54 to 58; Oats, 35 to 38 per cent. In some experiments the author estimated the starch in a sample of pure starch containing 89·36 per cent of dry starch. He obtained 87·72 per cent and 89·54 per cent. The author states as the result of his experience with the method, that the difference in results obtained by any two observers need not exceed 0·5 per cent of the total starch.

Dr. Armstrong said the paper was one of great value, and the amount of work involved was not by any means represented by the length of the paper. The progress of physiological chemistry must depend upon the accuracy of the means at our disposal of estimating the various constituents. Such researches must contribute a great deal to the investigation of vital problems.

In answer to Dr. Armstrong,

Mr. O'Sullivan stated that methylated spirit could be used in the extraction of the flour.

Dr. Percy Frankland then read a paper on the "*Illuminating Power of Ethylene when Burnt with Non-luminous Combustible Gases.*" The ethylene was prepared from methylated spirit and strong sulphuric acid, and purified by passing over various absorbents. It contained CO_2, 0·05; O, 0·94; C_2H_4, 97·52; N, 1·49. The non-luminous combustible gases experimented with were—hydrogen, prepared as usual from zinc and sulphuric acid; carbonic oxide, from potassium ferrocyanide and strong sulphuric acid; and marsh-gas. The product obtained by heating sodic acetate and soda lime was so impure that the author was obliged to prepare pure marsh-gas by decomposing zinc-methyl with water. The illuminating power was determined by an Evans's photometer; a Referee's burner and sperm candles being used. A sample of the gas was always taken at each determination and analysed. The illuminating power of ethylene, supposing 5 cubic feet per hour could be burnt, was found to be 68·5 candles. The illuminating power of ethylene when mixed with hydrogen shows an almost uniform diminution from 68·5 to zero when 90 per cent H is used. A mixture containing 25 per cent of ethylene had an i.p. 20 candles. In every case the i.p. of mixtures of ethylene and carbonic oxide was found to be less than that of the corresponding mixtures of ethylene and hydrogen. With marsh-gas it was found that mixtures rich in ethylene had about the same luminosity as those containing hydrogen and carbonic oxide, but that the i.p. of mixtures rich in marsh-gas greatly exceeded that of the corresponding mixtures with the two other gases. The intrinsic luminosity of the ethylene, calculated for a uniform consumption of 5 cubic feet per hour, continually increases as the percentage of marsh-gas rises. Thus the ethylene in a mixture containing 92 per cent of marsh-gas gives a light of 175 candles calculated for 5 cubic feet consumed per hour. The high illuminating power of coal-gas, considering the small quantity (4·51 per cent) of illuminating hydrocarbons that it contains, is probably explained by this great value of marsh-gas as a diluent. The explanation of this behaviour of marsh-gas is to be looked for in the quantity of heat developed in its combustion. Thus 1 mol. of H yields 68,924 units of heat; of CO, 67,284 units; of marsh-gas, 209,008 units. The author promises some further experiments on the effects of incombustible diluents.

Dr. Frankland many years ago had made somewhat similar experiments, and had then stated that marsh-gas was a diluent, and gave no illuminating power to coal gas. He experimented with a fish-tail burner. There seemed to be no doubt that the apparent rise of 4 to 5 candles in the illuminating power of coal-gas by the wonderful "Referee's burner," was largely due to the development of the illuminating power of the marsh-gas. For lighting purposes much marsh-gas was objectionable from the CO_2 produced and the quantity of heat developed, but where gas was used for heating purposes the case was quite different, and a large percentage of marsh-gas was most advantageous, owing to its great heating power.

Mr. G. S. Johnson then read a paper "*On the Products of Decomposition of Aqueous Solution of Ammonium Nitrite.*" The main points of interest observed are as follows:—No oxide of nitrogen is formed by alkaline solutions of pure ammonium nitrite. Nitrogen is evolved from such solution at temperatures below 100° C.; the evolution is facilitated by the pressure of spongy platinum. Pure nitrogen can be obtained by adding crystallised cupric chloride to solutions at the ordinary temperature. If solutions of ammonium nitrite be acidulated 40 per cent of nitric oxide is evolved. The author states that 2 per cent of the gas evolved by the action of cupric chloride consists of nitrogen in a peculiarly active state, setting free iodine from hydriodic acid, and forming ammonia when mixed with hydrogen and passed through a red-hot tube with spongy platinum. This active nitrogen is decomposed at a red heat, and is not produced if the temperature of the solution be raised above 90°.

Dr. Armstrong suggested that the nitrogen should be made in some other way. He did not think that passing the evolved gas over red-hot copper ensured the absence of oxygen. The quantity of ammonia formed was extremely minute; it seemed also excessively improbable that such an active form of nitrogen should exist.

Dr. E. B. Schmidt then read a short paper "*On the Estimation of Iron by Potassium Bichromate.*" The author recommends the above process; but states that zinc should not be used to reduce the iron, as it interferes with the end reaction with potassium ferricyanide. He prefers Kessler's method of reduction with stannous chloride. The author considers the reduction with sulphite of sodium tedious.

Mr. Riley said that the bichromate method was almost universally used for the estimation of iron; the difficulty when zinc was employed was also well known. Numerous analyses were constantly being made in his laboratory; the reducing agent employed being sodium sulphite. The whole subject was thoroughly discussed by him in a paper published some time back in the *Chemical Society Journal* (1877, vol. ii., p. 24, and 1862, xv., 311).

The Society then adjourned to Dec. 6th.

OBITUARY.

SIR WILLIAM SIEMENS.

We much regret to have to announce the sudden death of Sir William Siemens, which occurred on the evening of Monday last, the 18th inst., in consequence of an injury to the heart, brought about by a fall a fortnight previously. Walking home from a scientific meeting on the afternoon of Monday, the 5th inst., he tripped and fell while crossing Hamilton Place. Though for a day or two no apparent harm resulted, it was soon found that the heart had been—it was hoped slightly—injured, or, at all events, that the shock, acting on a previously existing morbid condition, had had injurious effects. Still there seemed no reason to fear that rest would not repair the mischief, till on Monday last, quite suddenly, the end came.

By his death English science has suffered a severe loss, and a loss which will not readily be made good. At a time when the tendency of science is more and more to specialise itself, and scientific men are often compelled to study one particular branch of a subject alone, it is very rare to find a mind like that of Sir William Siemens, who devoted himself to many distinct branches of science, and yet excelled in them all. Not only has he done much for the advancement of pure science, but it may be said without contradiction that he has, beyond all his

contemporaries, promoted the practical application of scientific discoveries to industrial purposes. He was an ardent scientific discoverer, a large and successful manufacturer in at least two distinct branches of industry, an engineer of high rank in the profession, and besides this he was a shrewd and clear-headed man of business.

Charles William Siemens was born at Leuthe, in Hanover, on the 4th of April, 1823. He was educated at the Gymnasium at Lübeck, afterwards at the Polytechnic School at Magdeburg, and finally at the University of Göttingen. Here he studied under Wöhler and Himly. In 1842 he became a pupil in the engine works of Count Stolberg, and here he laid the foundation of his engineering knowledge—knowledge he afterwards turned to such good practical account. The fact that he was one of a family of inventors makes it rather difficult to say what was the precise personal share he had in the many inventions for which the world is indebted to the four gifted brothers—Werner, William, Carl, and Frederick. They all worked so harmoniously together—the idea suggested by one being taken up and elaborated by another—that it is hardly possible to attribute to each his own proper credit for their joint labour. The task, too, is rendered all the harder by the fact that each brother was always ready to attribute a successful invention to any of the family rather than to himself. It may, however, be said that in electrical discovery the two brothers, William and Werner, were principally associated, while the regenerative furnace is due not only to William, but also to Frederick. It was to introduce to the English public a joint invention of his own and his brother Werner in electro-gilding that William Siemens first came to England. This was in 1843. Speaking two years ago to the Birmingham and Midland Institute, Dr. Siemens, as he was then, gave an interesting and somewhat touching account of the difficulties which not unnaturally beset the young foreign inventor, so ignorant of the language of the country that his first visit was to an "undertaker," under the impression that he was a suitable person to take up and bring out his invention. Thanks to the kindly discrimination of Mr. Elkington, who was able to perceive that certain processes described in some of his own patents could only be carried into effect by the improvements of the Siemenses, he was able to dispose of his invention so far successfully that he was induced in the following year to come back again on a similar errand. This time it was his "chronometric governor," an apparatus which, though not very successful commercially, introduced him into the engineering world, and was really the cause of his settling in this country. The chief use of this apparatus, intended originally for steam engines, has been found in its application to regulate the movement of the great transit instrument at Greenwich.

His studies in the dynamical theory of heat led him to pay special attention to methods of recovering the heat generally allowed to run to waste in various engineering and manufacturing processes. The first application of these researches was in the regenerative steam engine which he set up in 1847 in the factory of Mr. Hicks, at Bolton. In this superheated steam was employed, but its use was attended with certain difficulties which have prevented the commercial introduction of the invention. The Society of Arts may have the credit of being the first public body in England which recognised the value of the principle by awarding Mr. Siemens a gold medal in the year 1850 for his regenerative condenser. The direction in which he was then working was stated in a paper he read before the Institution of Civil Engineers in 1853 on the conversion of heat into mechanical effect. This paper gained him the Telford Premium and Medal of the Institution. In 1857 William Siemens, in connection with his younger brother and then pupil, Frederick, turned his attention to regenerative furnaces for metallurgical purposes. The regenerative gas furnace, as it is certainly the greatest invention due to the Siemenses, so is the one in which William Siemens is believed to have had the largest share. The first successful application of these furnaces was in 1861. The principle of the regenerative furnace is tolerably well known; it may suffice to say here that its main feature consists in an arrangement by which the waste heat of the products of combustion is utilised by being imparted to the air and to the gaseous fuel by which combustion is supported. This is effected by causing the products to pass through chambers in which the heat is taken up by masses of brickwork, and afterwards passing the in-coming currents of air and gas among the heated brickwork. The earlier applications of this principle to steel and glass making have been followed by its extension to many other industrial purposes in which great heat is required, the powers of the furnace being only limited in practice by the nature of the materials of which it can be constructed.

The application of the furnace to the making of iron and steel naturally led the attention of its inventor to other improvements in the same manufacture. In 1862 he endeavoured to reduce to practice the result of Reaumur's experiments in making steel by fusing malleable iron with cast steel. After some years experimenting the Siemens process of steel making was perfected, and a little later still the Siemens-Martin process. In the latter, scrap-iron is melted in a bath of pig-iron on the hearth of the furnace; in the former, ore is reduced. The production of steel in this country under Sir William Siemens's processes was over 340,000 tons in 1881.

But if the inventions of this regenerative furnace and of improved processes for steel making are those which are most likely to keep alive in future years the memory of their inventor, it is just now with the electric light that the name of Siemens is most closely associated in the popular mind. The precise date at which he may be said to have commenced his work in this direction can hardly be given. It was in 1867 that his classical paper on the conversion of dynamical into electrical force without the aid of permanent magnetism was read before the Royal Society. Strangely enough, the discovery of the same principle was enunciated at the same meeting of the Society by Sir Charles Wheatstone, while there is yet a third claimant in the person of Mr. Cromwall Varley, who had previously applied for a patent in which the idea was embodied. It, therefore, can never be quite certain who was the first discoverer of the principle on which modern dynamo machines are constructed. As regards the Siemens discovery, the originator of the idea was Dr. Werner Siemens, who on being shown an electrical motor constructed without permanent magnets, immediately saw that a generator without permanent magnets was equally possible. The details, however, of the construction of the Siemens machine, and the various improvements by which it has been brought to its present form or rather forms (for there are, of course, several varieties) are due alike to the younger and the elder brother. And the same may be said of the various inventions connected with telegraphy and the electric light which emanated from the great firm of Siemens Brothers. Some of these were entirely worked out by one, some by the other brother, more were the joint production of both, but no attempt was made to separate them or to discriminate. How great were the inventive resources of Sir William is well shown by the saying common in his workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half-a-dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

As regards telegraphy the most important work executed by the firm was the laying of the Direct United States Cable in 1874, for which work that remarkable vessel the *Faraday* was built after the designs of Sir William Siemens. A good instance at once of the versatility of Sir William's talents and of his engineering skill is given by the arrangement of the screw propellers in this ship. Their shafts (the *Faraday* is a twin screw) are set at a

slight angle, diverging, not outwards, as has often been proposed, but inwards, towards each other. The effect of this is that the thrust of each propeller, when used singly for steering purposes, acts at a much more effective angle, and the result is that the vessel can turn in her own length when the engines are worked in opposite directions. The *Faraday* is most completely fitted up with every possible appliance for cable laying, grappling, and recovering lost cables, but the above small detail is only referred to here as illustrating the way in which Sir W. Siemens dealt with a purely engineering question, which might have been considered quite beside the ordinary direction of his work. To record fitly what he and his firm have done for the advancement, not only of electric lighting, but of the various practical uses of electricity, would involve the enumeration of an infinity of technical details, each comparatively unimportant, but each fitting into its own place and serving to produce a complete whole. To enter fully into the amount of electric lighting work effected by them would invite comparisons which at the present moment are above all things to be avoided. It may, however, be said that if a careful examination were made of the working installations of the electric light, it would be found that a very considerable portion of the real work done had been done by the firm of Siemens Brothers. At the Paris Exhibition they were *facile principes*, at Munich, at Vienna, at the Crystal Palace, they were alike conspicuous. Visitors to the just-closed Fisheries Exhibition will remember how large a share of lighting there was effected by Messrs. Siemens. As regards the electrical transmission and conveyance of power, this is a field they have made peculiarly their own. With the exception (and an exception of undoubted importance) of storage batteries, the advances in this direction are principally due to them. The Berlin electric railway and that at Portrush are alike the work of one or other branch of the firm, while those who ever had the pleasure of being shown round his country house near Tunbridge Wells by Sir William can best realise how much he individually did to reduce to human servitude the forces of that mysterious power of which he was so great a master. Not only did electricity perform a large part of the actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits, And here we find the practical results of scientific work merging into the researches which have not yet borne their practical effects. Working at the subject of the electric light had of late led Sir William Siemens to considerations of the nature of light itself. The tendency of some of these thoughts is shown by certain of his recent communications to the Royal Society, including his last paper of all, in April last, "On the Dependence of Radiation on Temperature," and these, again, influenced by his earlier studies on the conservation of energy, led him to one of the most recent of his researches—that which produced his theory of the conservation of solar energy. Almost alone among all the results of his life's work, this theory of his dealt with a question not affecting—or at least not immediately affecting—human welfare. Whether from its novelty or as emanating from one not claiming to be an authority on the subject, the theory met with not a little sharp criticism when it was first put forward. Had its author lived but a few years longer he would, doubtless, have laboured to strengthen it with yet further observation and argument. As it is, it must remain as a daring and original suggestion, the effort of a keen and sagacious mind to bring to fresh subjects the experience and the knowledge accumulated by work of a totally different sort.

But to turn back again to those practical applications of scientific labour which were the real life-work of the subject of this notice—since without at least some mention of them the memoir would be still more incomplete than it is—almost a bare enumeration must suffice, but at least it will serve to show how varied were the talents we have just lost. The process of "anastatic printing," a process only superseded by recent advances in photographic processes, was due to William and Werner Siemens. It was described by Faraday in 1845. Faraday, too, it may be noted, had for the subject of his last lecture at the Royal Institution the advantages of the Siemens furnace. Improvements in calico printing, the invention of a double cylinder air-pump and of a water metre, are also among the earlier work of William Siemens. Among more recent inventions may be noticed his bathometer, for measuring the depth of the sea without a sounding line, his electrical furnace, his electrical thermometer and pyrometer, his rotatory furnace for the production of iron and steel by the direct process, his deep-sea electrical thermometer, and his regenerative gas-burner.

Sir William Siemens was elected a Fellow of the Royal Society in 1862, and in 1869-70 he served as one of the Council. He became a member of the Institution of Civil Engineers in 1854, and has been on its Council for some years. He was the first President of the Society of Telegraph Engineers, and served a second time in that capacity. He has been President of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the British Association. He was Chairman of Council of the Society of Arts, and was to have delivered the opening address of that society's session on Wednesday.

The honours he has received for his inventions and discoveries are very numerous. As above mentioned, the Society of Arts gave him a gold medal for his regenerative condenser in 1850. In 1874 the same society awarded him their Albert Medal for his improvements in metallurgy. At the Exhibitions of 1851 and 1862 he received prize medals, and in 1867 he was awarded a *grand prix* at the Paris Exhibition for his regenerative gas furnace and steel process. The Civil Engineers awarded him their Telford Medal in 1853, and only last week the same institution voted him their Howard Prize. This prize, which is given quinquennially to the inventor of an improved process connected with iron-making, has only been once awarded before, to Sir Henry Bessemer. In 1875 he received the Bessemer Medal of the Iron and Steel Institute. In April last he received the honour of knighthood in recognition of his scientific services. He was honorary member of various foreign scientific societies, and possessed several foreign Orders, among them the Legion of Honour. His contributions to scientific literature have been very numerous. Some of them have been referred to above, others will be found in the records of the Royal Society, the British Association, the Institution of Civil and Mechanical Engineers, the Society of Arts, and other bodies. This brief record may serve to show how valuable was the life that has just passed away, how great the loss of what a few more years of strenuous work might have yielded. Those who knew him may mourn the kindly heart, the generous, noble nature, so tolerant of imperfect knowledge, so impatient only at charlatanism and dishonesty; the nation at large has lost a faithful servant, chief among those who live only to better the life of their fellow men by subduing the forces of nature to their use. Looking back along the line of England's scientific worthies, there are few who have served the people better than this, her adopted son, few, if any, whose life's record will show so long a list of useful labours.—*The Times*.

Platinised Magnesium as a Reducing Agent.—M. Ballo.—Platinised magnesium promises to be a powerful reducing agent. The author added to a few c.c. water, nitrobenzol and alcohol, enough to effect solution. Magnesium, with the addition of a few drops of platinum chloride, occasioned a slight escape of gas, and the filtrate contained aniline. For the detection of nitrobenzol this kind of reduction may prove more advantageous than that with metals and acids, as the base is at once obtained in a free state.—*Berichte der Deutschen*.

CORRESPONDENCE.

BUNSEN'S GASOMETRY.

To the Editor of the Chemical News.

Sir,—In the article you were good enough to publish in the Chemical News, vol. xlviii., p. 229, on "A New Residual Product from the Distillation of Coal," I find some omissions have occurred which I hasten to correct. "Bunsen, in his 'Gasometry,'" should read—Bunsen, in the first edition of his "Gasometry." Many of your readers will know that in the last edition of the above work, published in 1877, a method is given for the extraction of benzol from coal-gas by means of alcohol, and this quantity so obtained is a trifle over what I am able to extract on the large scale. But, in addition to benzene, there is toluene, xylene; hexylene and other olefines; pentane and other paraffins; the ethine series; acids, bases, and naphthalene, and probably other substances. Without we know *accurately what* there are, how can we depend upon combustions of mixtures of these vapours? I hope to deal with the subject more completely during next month in a paper to be read before the Society of Chemical Industry.—I am, &c.,

George E. Davis.

The Manchester Chemical Club,
November 20, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 17, October 22, 1883.

Force of Induction due to the Variation of Intensity in the Electric Current of a Multiplier with a Flat Spiral, and the Comparison of this Force with that exerted at Great Distances by a Spherical Solenoid or an Artificial Solenoid Sun.—M. Quet.—A mathematical paper which does not admit of useful abridgment.

Determination of the Equivalents of Copper and Zinc by Means of their Sulphates.—H. Baubigny.—See p. 243.

Transformation of Hydrocarbides into the Corresponding Aldehyds by Means of Chloro-chromic Acid.—A. Etard.—Chloro-chromic acid combines in definite proportions with the hydrocarbides. These compounds are split up by water into an aldehyd and a salt of chrome.

No. 18, October 29, 1883.

Congelation-point of Alkaline Solutions.—F. M. Raoult.—The author divides the bases upon which he has experimented into two groups; the former comprising the alkaline earths and alkalies, along with tetra-methyl-ammonium and tri-methyl-ethyl-ammonium, whilst the latter includes ammonium, methyl-amine, tri-methyl-amine, ethyl-amine, propyl-amine, aniline, and nicotine. All the bases of the first group expel almost completely the bases of the second group from their salts in dilute solutions. The same fact has been already observed with acids. Both the strong acids and the strong bases when dissolved in water produce the normal molecular lowering of the congelation-point, bordering on 40, whilst feeble acids and bases produce merely an abnormal lowering of about 20.

Determination of the Equivalent of Nickel by Means of its Sulphate.—H. Baubigny.—Will be inserted in full.

Volumetric Determination of Iron by Means of a Solution of Sodium Hyposulphite and Sodium Salicylate.—G. Bruel.—This process is of great sensibility, being accurate to one-half milligrm. As compared with the process of Margueritte it has the advantage of nullifying the disturbing action of the air, since the iron is operated upon in the state of a per-salt. The author takes 1 grm. of pure iron, dissolves it in 20 c.c. hydrochloric acid, adds to the solution a few crystals of potassium chlorate, dilutes with water, and boils until the odour of chlorine is no longer perceptible. He then makes the solution up to 1 litre with distilled water, thus obtaining a solution of ferric chloride containing 0·001 grm. of iron per c.c. He then prepares a solution containing 1-1000th sodium hyposulphite in distilled water. He takes 10 c.c. of the ferric solution, puts it in a flask, adds four times its volume of distilled water, and raises the solution to a boil after having added 0·10 grm. sodium salicylate. The solution of hyposulphite contained in a Gay-Lussac burette, graduated to tenths of a c.c., is then poured drop by drop into the ferric solution, which becomes gradually decolourised. When the liquid presents merely a rose tint, scarcely appreciable, the burette is read off. When the solution of hyposulphite is thus standardised we may determine either the total iron present in a salt or in an ore, or the per-salt present in a partially oxidised proto-salt or in any salt of iron.

Detection of Blood upon Garments which have been Washed.—C. Husson.—When linen stained with blood has been thoroughly washed it is difficult to detect the characteristic elements. When the microscope and the spectroscope have detected neither hæmoglobine nor hæmatine, it would be imprudent to reckon upon the discovery of fibrine. But it may be important to show the care which the accused has taken to wash one part of a garment more than another. Water does not generally suffice to remove every trace of blood; the spot requires to be soaped, and when it is not afterwards rinsed with abundance of water, the linen or the garment generally retains traces of soap, which may be recognised without interfering with the search for crystals of hæmatine hydrochlorate. The author, having cut off a portion of the tissue at the suspected part, puts it in a watch-glass, and moistens it with a few drops of distilled water. The whole is kept for two hours on the sand-bath at about 40°, a drop of water being occasionally added to prevent drying up. The swatch is then pressed with small forceps, and the liquid which flows out indicates by its colour if crystals of hæmatine may be expected. This water is evaporated drop by drop on a slip of glass which serves for microscopic observation. If the liquid is too much spread out upon the glass, the residue is scraped and carefully brought to the centre of the slip, where it is retained by means of a drop of a solution of potassium iodide or chloride at 1-100th. The same portion of the tissue is put back in the watch-glass, and treated with a small quantity of glacial acetic acid, which, after being pressed out, is evaporated upon the first residue with the precautions laid down above. Having placed a disc of thin glass upon the residue glacial acetic acid is introduced by capillarity between the two glasses. It is heated to boiling and let cool, care being taken to slope the glass slip slightly so that the liquid which has not evaporated may collect at one of the angles of the thin glass cover. If there is still hæmatine the crystals of the hydrochlorate will appear. If there is soap, we find yellow drops of oleic acid along with margaric acid, which crystallises in characteristic needles, more or less curved. They appear first in the form of an elongated C. If there is much soap these needles unite, and form hairy dendriform masses. If there is but little they unite two by two, or in small fibrous tufts, which have a certain resemblance to fibrine fixed upon the fragments of the tissue. This similitude of form, though remote, may mislead. Filaments of fibrine, seen with the microscope without crystals or rays of hæmatine, do not seem a sufficient proof of the presence

of blood. When the washed spot is large enough a second portion may be cut off, boiled in distilled water, the liquid filtered through a very small filter, evaporated down, and ignited in a platinum capsule. The residue is taken up in a drop of distilled water, which turns the edge of a slip of red litmus paper blue. Both the acid and the alkali of the soap are thus demonstrated.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 16, No. 4.

The Magnetic Property of Platinum Ore.—Theodor Wilm.—The magnetic property of platinum ores varies greatly, and has little relation to the proportion of iron present. Experiment has shown that a purification of platinum ores with the magnet has no practical value, the non-magnetic portion being little richer in platinum than the more highly magnetic parts. To detect the intentional adulteration of platinum ores with iron filings, the author recommends treatment with pure hydrochloric acid at a gentle heat. With a genuine ore there is no evolution of gas, whilst with falsified samples there sets in a regular escape of hydrogen in bubbles.

Nitro-derivatives of Resorcin.—R. Benedikt.—The author points out certain omissions in P. G. W. Typke's paper (*Berichte*, xvi., 551).

Behaviour of Mono-nitranilines with the Chinolin Reaction.—W. La Coste.—Not capable of useful abridgment.

Cinnoline Derivatives.—V. von Richter.—The author gives the name cinnoline to a group of bodies, which may be viewed as chinoline, where the CH group, united with oxygen, is replaced by an atom of nitrogen. He describes at length oxy-cinnoline-carbonic acid, oxy-cinnoline, and cinnoline.

β-Naphtho-cumarine.—G. Kaufmann.—Naphthocumarine, $C_{13}H_8O_2$, is readily soluble in acetic acid, alcohol, ether, and chloroform; sparingly in hot water. It crystallises in vitreous felted needles, and melts at 118°. The aqueous solution displays a bluish fluorescence.

Sulpho Acids of Hydroquinone.—A. Seyda.—An examination of mono-, di-, and hydro-quinonic acids, with their principal salts.

Nitro-, Amido-, and Oxy-Methyl-anthraquinone.—H. Römer and W. Link.—A description in detail of nitro-methyl-anthraquinone, of amido-methyl-anthraquinone, acetyl-amido-methyl-anthraquinone, oxy-methyl-anthraquinone, and acetyl-oxy-methyl-anthraquinone.

Amido-methyl-anthranol.—H. Römer and W. Link.—An account of acetyl-amido-methyl-anthranol.

Violet Derivatives of Tri-phenyl-methan.—O. Fischer and L. German.—The authors examine and reject the view of E. and O. Fischer, that methyl-violet is to be regarded as a penta-methyl-para-rosaniline. According to their researches it contains six methyl groups, and on its conversion into methyl-green there occurs a perfectly normal quaternary formation of ammonium.

New Formation of Skatol.—O. Fischer and L. German.—The authors mix 100 grms. aniline carefully with from 70 to 80 zinc chloride, and heat in the oil-bath with 100 grms. glycerin to from 160° to 170°, afterwards to 240°. After this temperature has been maintained for two hours, it is acidified with very dilute sulphuric acid, and mixed with the distillate which has passed over. A current of steam is then passed through the liquid, and carries along with it an oil, from which the authors have separated skatol.

Oxy-quinoline Derivatives.—Otto Fischer.—The author gives a description of α-oxy-quinoline-tetra-hydride, α-oxy-hydro-methyl-quinoline, its hydrochlorate, known also as kairine, its sulphate, and picrate; oxy-hydro-ethyl-quinoline, the derivatives of ethoxy-quinoline, and its action upon the animal organism.

β-Oxy-quinoline.—C. Riemerschmied.—This memoir does not admit of useful abstraction.

A Correction.—L. Limpach.—The author corrects an error in the specification of Levinstein's patent for preparing the tri-sulpho-acid of β-naphthol.

Explanation on a Memoir on a Condensation-Product of Phenanthren-quinone and Acetacetic Ether.—F. R. Japp and F. W. Streatfield.—The authors complain of mistranslations in their memoir (*Berichte*, xvi., p. 462), and refer to the original in the *Journal of the Chemical Society*.

Tetra-hydro-quinoline.—L. Hoffmann and W. Königs.—The author gives an account of tetra-hydro-quinoline, its nitroso-compound, hydrazine, and tetrazone; its methylation, tetra-hydro-quinoline urea, benzoyl, and acetyl-tetra-hydro-quinoline; the oxidation of tetra-hydro-quinoline; its behaviour with sulphuric and nitric acids; with bromine; its behaviour at a red-heat, and the physiological effect of the hydrised derivatives of pyridine.

Aromatic Hydantoines.—A. Ehrlich.—The author has obtained ortho-toluyl-hydantoine and toluyl-hydantoinic acid.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Steatite.—Can you inform us for what purpose steatite is used. An article appeared in a paper lately about it saying that a new and very extensive use had been found for it, but our informant could not give us any particulars as to what paper he saw it in. It will be a great favour, therefore, if you can give us any information regarding it.—J. H. T.

MEETINGS FOR THE WEEK

MONDAY Nov. 26th.—Medical, 8.30.
TUESDAY, 27th.—Institute of Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 28th.—Society of Arts, 8.
FRIDAY, 30th.—Royal, 4. (Anniversary.)

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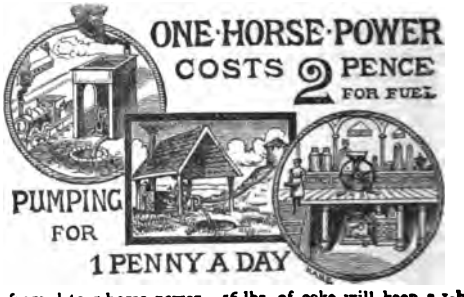

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1253.

ON THE PRESSURE OF THE VAPOUR OF MERCURY AT THE ORDINARY TEMPERATURE.*

By Professor McLEOD.

At the last meeting of the Association Lord Rayleigh called attention to a paper that had appeared in the *Annalen der Physik und Chemie* (N.F., xvi., 610), by Hagen, on the pressure of saturated mercury vapour at low temperatures. The pressures given for the ordinary atmospheric temperatures, although considerably less than those published by Regnault, appeared rather higher than some recent observations seemed to warrant. A method of determining the vapour pressure at ordinary temperatures seems to have occurred to Mr. Crookes and myself almost simultaneously, and I much regret that his absence from the present meeting prevents us from learning the results of his work. Mr. Crookes intended to try the experiment *in vacuo*, whereas I thought of saturating air with mercury vapour; but we both intended to determine the quantity of evaporated mercury by a chemical test.

A glass flask of about 1·9 litres capacity was employed for the experiment, and within it was supported, by a piece of string, a glass tube 14 m.m. in diameter, and filled with freshly-distilled mercury, the flask being closed by a greased glass plate. After standing at the temperature of the laboratory for about nine days, the mercury tube was removed, and a small quantity of boiling nitric acid poured into the flask and left to stand for some time. The acid was next neutralised by ammonia, and after the fumes in the flask had disappeared, the liquid was washed out with water, acidulated with hydrochloric acid, and treated with sulphuretted hydrogen. A slight brown colouration resulted. Several standard solutions of mercury were then made, and tested with sulphuretted hydrogen in the same manner. The liquid from the flask gave a deeper colour than the solution containing 0·00006 grm. of mercury, and a lighter colour than that containing 0·00012 grm. It may therefore be assumed that the flask contained about 0·00009 grm. of mercury vapour.

Subsequently the same flask was used, and a tube of mercury 24 m.m. in diameter (or exposing nearly three times as much mercury surface as the first) suspended in it, and allowed to stand for a month. Treated in a similar manner, the colour was nearly the same (a little lighter if anything) as that produced by a solution containing 0·00012 grm. of mercury. One litre of the air in the flask therefore contained—

$$\frac{0{\cdot}00012}{1{\cdot}9} = 0{\cdot}00006316 \text{ grm. mercury.}$$

As the theoretical weight of a litre of mercury vapour at 20° C. and the normal pressure is 8·3474 grms., the volume of the vapour in 1 litre of the air was—

$$\frac{0{\cdot}00006316 \times 1000}{8{\cdot}3474} = 0{\cdot}007566 \text{ c.c.,}$$

or $\frac{1}{132\cdot16}$ of the total volume. The pressure of the mercury vapour was therefore—

$$\frac{760}{132160} = 0{\cdot}00574 \text{ m.m.,}$$

whereas Hagen's number for 20° is 0·021 m.m.

It may be observed that this method might have been expected to give rather an excess than a defect of the quantity of mercury, in consequence of condensation of mercury on the sides of the flask, and although the experiment was of a somewhat rough character, it seems to show that Hagen's number is too high.

A paper has also been published by Hertz (*Ann. Phys. u. Chem.*, N.F., xvii., 193), in which he estimates the pressure of the vapour at 20° to be only 0·0013, or only about one-fifth as great as indicated by the foregoing experiments.

* Read before the British Association, Southport Meeting.

METHOD FOR PREPARING URANIC NITRATE OR ACETATE FROM THE RESIDUES.

By J. T. SAVORY, F.I.C.

The precipitate of uranyl phosphate, or uranyl ammonium phosphate, is washed by decantation until free from soluble salts. It is now dried, powdered, and ignited to expel ammonia from the double phosphate. The resulting uranyl phosphate is then dissolved with the aid of heat in pure strong nitric acid, and while the solution is still on the water-bath, pure, coarsely-granulated tin is added in small portions, in quantity equal to one-half the weight of the phosphate. When the action has ceased the mass is evaporated to dryness, and gently heated on a sand-bath. The stannic oxide containing *all* the phosphoric acid is then broken up, and boiled out with successive portions of nitric acid (one in four), allowing to settle after each treatment, and filtering through Swedish paper. The solution of uranyl nitrate is then concentrated, and the salt crystallised out, and drained on a porous tile. Recrystallisation is generally unnecessary.

If the acetate be required, the solution of the nitrate is evaporated to dryness, and gently heated till acid vapours are no longer given off, and the remaining uranyl oxide, which should be yellowish red if not too strongly heated, is dissolved in warm acetic acid, filtered, and the acetate crystallised out as in Wertheim's method.

It is important that the tin used should be pure and also not too finely divided. If the powdered metal be used the action is very violent, and portions of it are fused, and even become incandescent and cause spirting. The stannic oxide produced, too, will be difficult to filter, being very finely divided. If the acid used be not heated, or too dilute, stannic salt may be produced, which, by slowly decomposing, would make the solution turbid.

This method gives a yield of over 90 per cent, and is less troublesome than that of Reichard.

Laboratory of the Royal Agricultural Society,
November 22, 1883.

ON THE ATOMIC WEIGHT OF TITANIUM.*

By T. E. THORPE F.R.S.

The stoichiometrical quantities which we ordinarily term atomic weights are not only the fundamental constants of chemical calculations; their relations as mere numbers are of the highest significance in connexion with our conceptions concerning the essential nature of matter.

The recent publications of Becker and Clarke in America, and of Dr. Lothar Meyer and Seubert in Germany, have served to demonstrate on how slight an experimental basis a large number—the greater proportion, it must be confessed—of the accepted values of these constants really depend.

A notable instance of this fact is seen in the case of titanium. The atomic weight of this element was determined by Rose in 1829, and by Pierre in 1847, with the following results:—

Rose	48·13 and 49·58
Pierre	50·25

* A Paper read before the Royal Society, November 22, 1883.

his periodic law is 48, a number which finds some experimental support from the observations of Rose. The direct evidence in favour of either value is, however, very slight, and a critical examination of the observations affords no ground for assuming that Rose's value is nearer the truth than that of Pierre. It is probable that the value 48 has been adopted in one or two modern text-books, mainly because it agrees best with the requirements of the periodic law.

I have attempted to deduce the atomic weight of titanium from observations made with the tetrachloride, the tetrabromide, and the dioxide. The present communication contains the results furnished by the analysis of the chloride. The work with this body affords three independent values for Ti based on the ratios—

I. .. .. $TiCl_4 : 4Ag$
II. .. .. $TiCl_4 : 4AgCl$
III. .. .. $TiCl_4 : TiO_2$

Series I.—$TiCl_4 : 4Ag$.

Weighed quantities of the tetrachloride were decomposed by water in closed vessels, and the chlorine precipitated by silver after the method of Gay-Lussac as modified by Stas—

	Chloride taken.	Silver employed.	Ti(H=1).
I.	2·43275	5·52797	48·06
II.	5·42332	12·32260	48·07
III.	3·59601	8·17461	47·99
IV.	3·31222	7·52721	48·05
V.	4·20093	9·54679	48·05
VI.	5·68888	12·92686	48·06
VII.	5·65346	12·85490	47·95
VIII.	4·08247	9·28305	47·94
	34·39004	78·16399	48·021

Series II.—$TiCl_4 : 4AgCl$.

Weighed portions of the tetrachloride after decomposition with water were treated with excess of silver nitrate, and the silver chloride separated by reverse filtration and weighed :—

	Chloride taken.	Silver Chloride.	Ti(H=1).
IX.	3·31222	10·00235	47·99
X.	4·20093	12·68762	47·98
XI.	5·68888	17·17842	48·00
XII.	5·65346	17·06703	48·06
XIII.	4·08247	12·32442	48·06
	22·93796	69·25983	48·018

The total amount of the silver chloride thus obtained was 69·25983 grms. : it was formed from 53·13881 grms. of silver added in the preceding series. The weight of the silver chloride thus obtained from a known weight of silver and of titanium tetrachloride, not only affords an additional value for Ti, but it also serves as a rigorous check on the accuracy of the work, for if the ratio of Ag to AgCl turns out to be the same as that obtained by the direct union of chlorine and silver, it at once disposes of the possibility of error due to the co-precipitation of titanic acid, and is a guarantee of the purity of the silver employed—

Now $52·13881 : 69·25983 = Ag : AgCl = 1 : 1·3284$.

Stas found from seven experiments in which, in the aggregate, 969·3548 grms. of silver were found to give 1287·7420 grms. of silver chloride, that—

$$Ag : AgCl = 1 : 1·32845.$$

The two ratios, it will be seen, are almost identical.

solution evaporated to dryness and strongly heated:

	Chloride taken.	Titanic Oxide.	Ti (H=1).
XIV.	6·23398	2·62825	47·93
XV.	8·96938	3·78335	48·00
XVI.	10·19853	4·30128	47·95
XVII.	6·56894	2·77011	47·96
XVIII.	8·99981	3·79575	47·98
XIX.	8·32885	3·51158	47·94
	49·29948	20·79032	47·970

All the experiments which were made, either for the estimation of the chlorine or the titanic oxide, are given with the exception of two; one of these was made upon a small quantity of material, and was considered as merely preliminary; the other miscarried, and was not persevered with.

In order to enable an opinion to be formed as to the agreement among the several observations, I have calculated the value of Ti afforded by each experiment. But probably the most accurate values of Ti would be deduced from the aggregate weights of the tetrachloride, silver, silver chloride, and titanic oxide, respectively. Inasmuch as it may be presumed that the employment of large quantities of material would tend to increase the accuracy of the result, by calculating the final values from the aggregate weights instead of merely taking the means of the several observations, the influence of the larger quantities is directly felt.

Assuming with Lothar Meyer and Seubert that the most probable ratios of Ag, Cl, O, and H are as follows—

Ag = 6·7456
Cl = 2·21586
O = 1
H = 0·06265

the various experiments afford the following values for Ti :—

I. $TiCl_4 : 4Ag$ = 34·39004 : 78·16399
= 1·75989 : 4
$TiCl_4 : O$ = 11·8715 : 1
Ti : O = 3·0081 : 1
Ti : H = 48·014 : 1

II. $TiCl_4 : 4AgCl$ = 22·93796 : 69·25983
= 1·32475 : 4
$TiCl_4 : O$ = 11·8716 : 1
Ti : O = 3·0082 : 1
Ti : H = 48·016 : 1

III. $TiCl_4 : TiO_2$ = 49·29948 : 20·79032
= 2·37124 : 1
Ti : O = 3·0053 : 1
Ti : H = 47·969 : 1

On the assumption that these values have equal weight, the final value becomes—

I. .. .. 48·014
II. .. .. 48·016
III. .. .. 47·969

Ti = 48·000

It would appear, therefore, from these observations that titanium must be added to the increasing list of the elements whose atomic weights are simple multiples of that of hydrogen.

In these observations, which have occupied me many months, I have sought to eliminate such sources of error as were known to me. It is of course possible, in spite of the agreement between the several values, that the results may be affected by undetected and constant errors. Experience warns us that no determination of atomic weight, however well the individual observations may agree among themselves, can be considered wholly satisfactory

if it depends upon a single reaction or is referred to a single relation. It is for this reason that I have sought to extend my observations to other compounds of titanium, and to vary the nature of the reactions involved in the chemical processes. Unfortunately, it is found that comparatively few bodies containing titanium lend themselves to the purpose of atomic weight determination. I am, however, making observations with the tetrabromide, which, in some respects, is to be preferred to the tetrachloride, and the results furnished by its analysis will be given in a second communication, which will also contain details respecting the preparation of the substances used, the methods of weighing, the processes of manipulation, effect of errors, &c. With reference to the tetrabromide, I may here say that I find it can be very easily made by the action of hydrobromic acid gas upon the chloride, and that this proves to be a more convenient method of preparation than that by which it was first obtained by Duppa.

ELECTRO-CHEMICAL RESEARCHES ON NITROGEN.

By GEORGE STILLINGFLEET JOHNSON.

IN November, 1881, a paper of mine was read before the Royal Society, entitled, "On Allotropic or Active Nitrogen, and on the Complete Synthesis of Ammonia." In that paper, which has not been published, were recorded the results of a series of experiments which had at that time led me to believe in the duality of nitrogen, a belief which has been confirmed by subsequent investigation.

At the time when my paper was read before the Royal Society, I was not aware of the investigations of M. H. Sainte-Claire Deville in this field (*vide Comptes Rendus*, 1865, lx., pp. 324 and 325). He demonstrated that the dissociation of ammonia gas by the spark was never complete.

I observed, in 1881, as I believe for the first time, that a mixture of pure nitrogen and hydrogen gases, in a perfectly dry state, and confined, either over pure sulphuric acid or over mercury in presence of charcoal, and in the requisite proportions to form ammonia, may be completely converted into that gas by a series of electric sparks; the ammonia being absorbed by the charcoal in the one case and by the acid in the other. Deville confined himself to effecting the complete conversion by a series of electric sparks of a mixture of nitrogen gas with three times its volume of hydrogen gas, and twice its volume of hydrochloric acid gas, into *sal-ammoniac*, but he did not demonstrate the synthesis of ammonia by passing the spark through pure $N+H_3$ gases in presence of an absorbent, such as charcoal or H_2SO_4, incapable of yielding any vapour which might mingle with those gases, and thus modify the result. Nevertheless, this experiment of Deville's approached as near as possible to a demonstration of the possibility of synthesising ammonia by the electric spark, though it left the explanation of the incomplete dissociation of ammonia by that agent still obscure, inasmuch as, until the formation of NH_3 by the action of a series of electric sparks upon pure $N+H_3$ gases was absolutely proved, two hypotheses would still account for the small residual trace of ammonia left after the experiment, viz. (1st), incomplete decomposition, and (2nd) complete decomposition in the first place, followed by recombination of a portion of the gases.

Now, since I have shown that when the spark is passed through *pure* $N+H_3$ gases in the *absence* of any absorbent for ammonia, as when the gases stand over mercury *e.g.*, a small quantity of ammonia only is produced, which never accumulates, it is clear that both these causes operate; synthesis first takes place, and as soon as the ammonia gas reaches a certain tension in the mixture, dissociation occurs as fast as ammonia is produced.

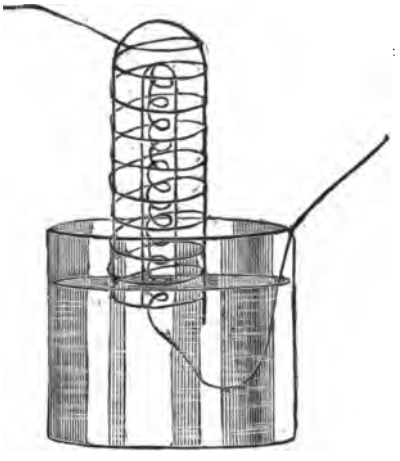
In the course of my work, recorded in November, 1881, I endeavoured to accumulate active nitrogen by means of the effluve, or silent discharge.

Prolonged Action of the Effluve upon Nitrogen and Hydrogem.

It is known that oxygen is rendered active by this agent, the gas becoming converted into ozone, which is generally regarded as $-O_2$ combined with $+O$. Now, as the distinguishing feature of active nitrogen appears to be the comparative readiness with which it combines with hydrogen to form ammonia, and as we may presume the N in ammonia to be electro-negative, we naturally turn to the effluve as the agent most likely to produce this allotropic nitrogen in quantity. In my first experiments, recorded November, 1881, I failed in this endeavour, for reasons which will become obvious on considering the following observations:—

Having incidentally discovered that a mixture of hydrogen and oxygen gases in proportions H_2+O may be exploded without the agency of sparks by a current of electricity passed round the glass vessel containing them, a result which has been since this confirmed by MM. Déherain and Maquenne in a paper published by them in the *Comptes Rendus*, I proceeded to make some further experiments with mixtures of H and O in other proportions submitted to the same influence. The apparatus employed consisted of two tubes, each closed at one end and open at the other, and fitting loosely the one into the other, the space left between them being occupied by the gases under observation. These gases were confined in the tubes by water, in which the open ends of the tubes were immersed. Coils of copper wire were twined round the exterior of the outer tube and the interior of the inner one, these two coils being separated from one another by the glass walls of the two tubes, and connected with a Rhumkorff coil capable of giving a two-inch spark in the air, and fed by four Groves cells. (Fig. 1.)

FIG. 1.



It was observed that when the explosive mixture between the walls of the two tubes was diluted largely by either of the ingredients, a perceptible *time* elapsed before explosion occurred under the influence of the effluve. On some occasions explosion occurred at last after the electricity had traversed the tubes for a period of from one to two hours.

Guided by these results, I determined to submit a mixture of nitrogen and hydrogen gases to the *prolonged* action of the effluve in the apparatus figured above, knowing that it would be useless to attempt to accumulate active nitrogen by an agent, or in an apparatus in which combination between nitrogen and hydrogen gases could not be effected. Accordingly, a mixture of atmospheric

the proportion $N+H_3$ had been reached. 45 c.c. of this mixture was introduced between the two glass tubes described and figured above, and the effluve was passed through the gases for a number of hours, the confining liquid being water faintly acidulated with sulphuric acid and coloured red by solution of litmus. Very slow and gradual contraction took place. After *fifty hours*, the volume of the gas was reduced to 27 c.c., showing a contraction of 13 c.c., yet was the liquid even in the tube quite red, showing the absence of *free* ammonia. This result, which was verified again and again, caused much surprise, but light is thrown upon it by the recent observation of MM. Déherain and Maquenne that the vapour of water is dissociated under certain conditions by the effluve, which suggests the following explanation of the reaction :—

$$\underbrace{N_2+H_6}_{8\text{ vols.}}+2H_2O=NH_4.NO_2+\underbrace{H_6}_{6\text{ vols.}}.$$

And this is confirmed by the observation of MM. P. and A. Thénard (*Comptes Rendus*, lxxxvi., 517, 1508), that nitrogen gas, subjected to the influence of the effluve in presence of aqueous vapour, disappears, and forms a body which appears to be *ammonium nitrite*.

From my experiments just cited, it seems that even in presence of hydrogen in sufficient quantity to form ammonia by combination with it, nitrogen gas in presence of aqueous vapour and under the influence of the effluve, will, under certain conditions, yield no free ammonia, but ammonium nitrite.

Berthelot has confirmed the experiments of Thénard as regards the action of the effluve upon a mixture of nitrogen gas and aqueous vapour. Berthelot finds (*Bull. Soc. Chim*, [2], xxvii., 338) that ammonium nitrite is formed when perfectly pure nitrogen gas and water are enclosed between two concentric tubes and subjected to the action of a powerful Rhumkorff's coil.

The following experiment, however, shows the influence of *tension* of the electric current in modifying the results obtained :—

The same apparatus, the same gases, and the same electrical arrangements were employed as in the experiments last recorded, the only difference being that the tubes were gently warmed by a burner placed in their vicinity just sufficiently to keep the glass *dry*. The contraction became at once much more rapid, and free *ammonia* was formed as shown by the blueing of the litmus in the liquid as it rose up the tube.

To ascertain whether the *heat* applied had any action in causing combination, other than in drying the glass, I performed a perfectly similar experiment to the above, substituting oil of vitriol for the water as the confining and absorbing liquid, so that the walls of the tubes were kept dry without any application of heat at all. Contraction took place as rapidly as before on passing the effluve through the dry gases. In this connection, I must quote the experiments of Berthelot (*Comptes Rendus*, lxxxii., 1283, 1360), who has shown that when nitrogen and hydrogen combine under the influence of the effluve, not more than 3 per cent of the gases ever combine to form ammonia, unless some absorbent be present to remove it as it is produced.

The points of interest in my experiments are (1) they indicate that electricity of a higher tension is required to cause combination between N and H to form ammonia, than is necessary to the production of ammonium nitrite by the union of N, H, and O* ; and (2) they confirm the ensuring the perfect *dryness* of nitrogen gas which we attempt to render *active* by the silent discharge. I may add that my failure to accumulate active nitrogen in my first experiments is accounted for by the fact that no special precautions were taken to render the gas thoroughly *dry* before its entrance into the induction-tube, so that the aqueous vapour present in the gas prevented the possibility of the formation of free electro-negative N, *ammonium nitrite* being found instead. The only statement in my paper of 1881 which I wish to modify is this, that "nitrogen gas is not rendered active by the effluve," and the modification I would introduce is the following, unless the gas be perfectly dry and the electricity of high tension :—

Behaviour of Nitrogen and Hydrogen Gases in Grove's Gas Battery.

I was induced to investigate the behaviour of nitrogen and hydrogen gases in Grove's gas battery in the expectation that by virtue of the so-called "polarisation" of the platinum plates known to occur in that apparatus, the nitrogen might receive an excess of electro-negativity, and be thus rendered capable of combining with hydrogen to form ammonia.

The apparatus employed consisted of a series of four cells, each provided with two tubes of glass 10 inches in length and half an inch in diameter. Platinum wires of good thickness were fused into the closed ends of these tubes in the usual way, and soldered below on to platinum plates nearly as wide as the tubes, varying from 8½ to 9 inches in length, and thickly covered with electro-deposited platinum (platinised).

Method of Experimentation.

The liquid under experiment having been introduced into the cell and the tubes filled with it by inverting the cell as usual, pure hydrogen was introduced into each cell by displacement in the usual way and left till no current showed itself on making contact with the galvanometer. This precaution was taken in order to remove all occluded *oxygen* from the platinum plates. The liquid was then again introduced into the tubes by simply inverting the cell as before. Into one of the tubes pure nitrogen was then introduced. This was always effected in the same way, viz., by forcing air from bellows through potash and strong sulphuric acid, and then through a tube 22 inches in length, packed with freshly-reduced copper from copper oxide by hydrogen, a clip being attached to the india-rubber tube connecting the extremity of the copper tube with the glass delivery tube entering the acid of the cell, so as to regulate the stream till it became very slow, the air in the copper tube being consequently under pressure, which would assist the complete absorption of the oxygen by the heated metal. As soon as 1 inch of the reduced copper showed signs of oxidation, a stream of hydrogen was made to traverse the heated copper till reduction was again complete. The nitrogen having been introduced, its volume was marked off upon the tube (as soon as it had cooled), and pure hydrogen (purified by passing through solution of mercuric chloride) was then introduced into the opposite tube, and its volume also carefully marked. Contact was then made between the two tubes by metallic wire, and any contraction which might occur carefully observed.

Experiments showing the Influence of Acids of Different Strengths in the Cells upon the Amount of Contraction.

In the first experiment, conducted in the manner above described, four cells were charged with dilute sulphuric acid, no care being taken to ensure an equal strength of acid in each cell. Contact was made between the hydrogen and nitrogen plates of each cell alternately with its adjacent cell, when contraction began in one of the

* This seems to be the only possible explanation of the different effect observed when the effluve is passed through $N+H_3$ gases in presence of aqueous vapour, first, in a *moist* glass envelope, and, secondly, in a *dry* one, the moist glass in the first case causing loss of electricity by conduction down the tube into the acidulated water, and thus diminishing the tension of the electricity left free to act upon the confined gas.

hydrogen tubes, and after a great part of the gas had disappeared from that tube, the hydrogen in another cell was observed to be contracting. This was the first indication I received that the amount of contraction is influenced by the strength of the acid in the cell. I followed this up, till I discovered that the amount of contraction varies with the *conductivity* (electrical) of the acid in the cell; the most marked contraction, and also the strongest currents being produced with the acids of highest conducting power. For this reason I experimented usually with dilute sulphuric acid of specific gravity 1·220, that being the strength of acid which is possessed of most conducting power, according to the tables of Kohlrausch (*Pogg. Ann.*, clix., 233). When hydrochloric acid was employed, it was used of specific gravity 1·100, acid of this strength being not only a better conductor than hydrochloric acid of any other strength, but even a slightly better conductor than sulphuric acid of specific gravity 1·220; according to Kohlrausch (*loc. cit.*), if the conductivity of dilute H_2SO_4 of sp. gr. 1·2207 be represented by the number 6912, that of dilute HCl of sp. gr. 1·1001 is represented as 7132.

Experiments showing the Influence of Varying Resistance to the Electric Current in the Metallic Wires employed for making Contact between the Platinum Plates in the two Tubes.

My first experiment with nitrogen and hydrogen in Grove's gas battery put me on my guard in respect to the strength of the acids in the cells. The second showed that the conductivity of the wires used for connecting the platinum plates together was of no less importance. In this case I was very careful that all the acids should be of equal strengths, but instead of making contact with *copper* wires as at first, I used thin platinum wires for this purpose. The result was a complete absence of contraction in *all the tubes*. But on making contact with the *same* platinum wire between the hydrogen and nitrogen plates in a *single* cell, the hydrogen in that cell began to contract at once, and the same with all the others in turn, though they had retained constant volumes for some days previously when connected alternately, the hydrogen of one cell with the nitrogen of the next. I subsequently discovered that if thick copper wires were used to connect the plates, contraction occurred in all the cells simultaneously when alternately connected.

Description of Experiments with Nitrogen and Hydrogen in Cells containing two Tubes each.

When the acid in the cell was dilute sulphuric (1 to 6 of water), contact being made between the hydrogen and nitrogen plates of the same cell with thin platinum wire, and 1 inch of each plate being immersed in the acid, in all cases the hydrogen *contracted*, whilst the nitrogen *increased* in volume. When two-thirds of the nitrogen plate was immersed in the acid, and only one-ninth of the hydrogen plate was in the same condition, the gases in both tubes contracted in the proportion 1 : 3, but *very slowly*.

After the hydrogen in a cell containing two tubes originally full of N and H, connected by thin platinum wire and immersed in the dilute sulphuric acid (1 to 6) had diminished in volume by one-half, the gas in the nitrogen tube, which had been continually expanding, and had therefore of necessity been two or three times partially expelled by inverting the cell, so as to keep its platinum plate in contact with the acid, was transferred to a graduated tube over mercury, mixed with a known volume of oxygen, and then subjected to the action of a piece of platinum sponge. By the contraction observed, the gas was found to contain 18 per cent of hydrogen.

In the above experiment, though the acid was a good conductor, the resistance offered by the wire was considerable, hence no evidence was observed of *combination* between the nitrogen and hydrogen; indeed, if any combination took place at all, it must have been extremely small, since the *expansion* of the nitrogen appeared to be equal to the contraction of the hydrogen gas, *i.e.*, when both tubes were originally nearly full of N and H respectively. Even when the nitrogen had a smaller volume than the hydrogen, the contraction of the N first observed soon ceased and was followed by expansion.

The acid next employed was sulphuric acid of sp. gr. 1·37, which has a conductivity represented by the number 5500 (nearly) on Kohlrausch's scale.

When acid of this strength was introduced into a cell containing two tubes charged with pure nitrogen and hydrogen gas in the manner above described, the platinum plates being 10 inches in length, 4 inches of each being immersed in the acid, and contact being made with thick copper wire between the two plates, *both* gases contracted very slowly in proportions 1 N : 3 H. On making contact with a delicate galvanometer, a current was observed passing from the H plate to the N plate, which deflected the needle about 2°. This current, as in all cases with N and H in Grove's gas battery, ceased after a few seconds, but re-appeared on disconnecting for a minute or two, and then again making contact with the galvanometer. (N.B. The galvanometer employed possessed long coils of wire, and therefore must have offered considerable resistance.)

After *twenty-two hours*, the contraction of the hydrogen amounted to four-fifths of an inch, whilst the nitrogen had contracted one-fifth of an inch. The galvanometer still showed a deflection of 2° produced by a current passing from the hydrogen plate to the nitrogen one.

In my next experiment I employed dilute sulphuric acid of sp. gr. 1·184, whose conducting number would be about 6300, an acid of much better conductivity than the last. The platinum plates in this case were 9 inches long, and 2·2 inches thereof were immersed in the acid. On making connection by a short thick copper wire between the two plates, the hydrogen began to contract rapidly at once. The nitrogen at first retained a constant volume, afterwards slightly contracted, and subsequently *expanded*, the hydrogen still contracting, but more and more slowly.

A few minutes after making connection, whilst the hydrogen was rapidly contracting, connection was made with the galvanometer, when the needle was deflected 45° by a current passing from the H to the N plate.

After one hour, the deflection only amounted to 15°.

After *twenty* hours the hydrogen had undergone a total contraction of 1 and 4-5ths inches, whilst the nitrogen had expanded 3-5ths of an inch. The deflection of the galvanometer needle was now reduced to 6°.

It will be observed that in the above experiment the contraction of the hydrogen was *three times* as great as the expansion of the nitrogen, so that a large proportion of that gas must have combined; also that in addition to rapid contraction with (at all events) partial combination of the hydrogen with contents of the nitrogen tube, a much more powerful deflection of the needle of the galvanometer was produced by the plates immersed in acid of a better conducting power than in any hitherto employed.

Several experiments were now made with dilute H_2SO_4, sp. gr. 1·220, conducting number 6912 (best conducting sulphuric acid). A cell with its two tubes having been charged with the acid in the usual way, the tubes were half filled with pure nitrogen and hydrogen gases respectively. Thick copper wire used as connection.

The hydrogen contracted rapidly, whilst the nitrogen at first very slightly contracted, then retained a constant volume, and finally began to expand.

After three-quarters of an hour, the current from H to N deflected the needle of the galvanometer 45°,* the contraction of the hydrogen being at that time 1¼ inches. In two hours more the total contraction of the hydrogen amounted to 1⅞ths inches (nearly 2 inches), whilst the nitrogen had *increased* in volume only 1-6th of an inch.

* In an experiment with sulphuric acid of the same strength, in which contact was made with the galvanometer, *immediately after* introducing the gases, the deflection of the needle amounted to 95°.

presumably with nitrogen.

In the case of *sulphuric acid*, it would be difficult to prove the formation of ammonia in such small quantities and its accumulation in the liquid of the cell, and for this reason I now substituted dilute *hydrochloric acid* for the sulphuric acid, employing an acid of sp. gr. 1·1001, with the object of subsequently detecting the ammonia produced (if any) by mixing the acid of the cell with platinic chloride and evaporating, to estimate the NH_3 as $PtCl_4.2NH_4Cl$ in the usual way.

The method of experimentation being unaltered in my first experiment with dilute HCl of sp. gr. 1·100, the phenomena were very similar to those noted in the case of dilute H_2SO_4 of sp. gr. 1·220. Thus, after eighteen hours, the hydrogen had contracted 1¾ths inches, whilst the nitrogen, which had at first retained a constant volume, but subsequently expanded as before, had increased in volume $\frac{7}{10}$ths of an inch. Hence, in this experiment, more than half the hydrogen had disappeared altogether from view.

My next experiment was instituted with a view to determine whether the contraction of the hydrogen in contact with a platinum plate partially immersed in an acid of good conducting power, which I had invariably observed when the hydrogenised plate was in contact with another one immersed in the same liquid and surrounded by nitrogen gas, was really due to some electro-chemical changes going on between the plates and the gases, or whether mere connection with another platinum plate would be sufficient to produce the disappearance of the hydrogen gas. This experiment was conducted as follows:—

One cell with a pair of tubes was charged with pure nitrogen and hydrogen gases, as above described. The liquid in this cell was dilute hydrochloric acid of sp. gr. 1·100. Two other cells, containing each dilute sulphuric acid, of sp. gr. 1·220, were charged, both tubes of the one with pure hydrogen gas, and both tubes of the other with pure oxygen. The cell containing HCl and nitrogen and hydrogen gases being placed between the other two cells, connection was made by thick copper wire between the nitrogen plate of the central cell and one of the hydrogen plates of the hydrogenised cell on the one hand, and between the hydrogen plate of the central cell and one of the oxygen plates of the oxygenated cell on the other. The remaining hydrogen and oxygen plates were then connected by similar wire, as in Fig. 2.

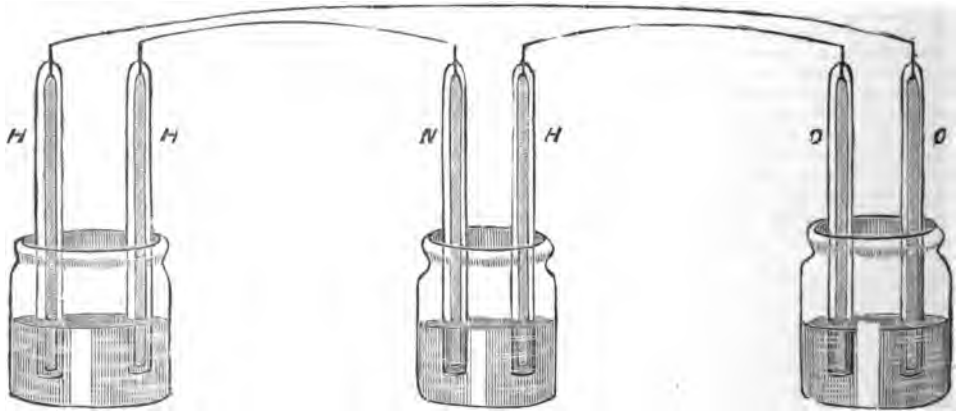
After leaving the several tubes with their respective plates connected, as above described and figured, for *twenty hours*, *all* the gases were found to be quite unaltered in volume with the exception of the nitrogen, which had

have frequently observed. In the tubes employed by me, which were ¼ inch in diameter, it never carried the liquid higher up the tube than 1·10th of an inch, and I attribute it to the combination of a portion of the nitrogen gas with hydrogen occluded in the platinum, and possibly to the subsequent occlusion of some of the nitrogen itself by the platinum.

Now, on breaking connection between the hydrogen plate of the central cell and the adjacent oxygen plate, and connecting it with the nitrogen plate of its own cell, the hydrogen gas in the central cell began to contract as usual. This result strengthens the idea that some chemical combination takes place between the nitrogen and hydrogen gases in Grove's gas battery.

When three cells, all containing acid of good conducting power, and each having two tubes filled with pure H and N respectively, were connected alternately, the H plate of one cell with the N plate of the next seriatim, all the hydrogens contracted, somewhat more rapidly than in a single cell, provided the connecting wires were short and thick, and of copper. The nitrogen usually contracted slightly at first, but soon ceased contracting, and began to expand after a few hours. The current produced on

FIG. 2.



H_2SO_4. Sp. gr. 1·22. HCl. Sp. gr. 1·10. H_2SO_4. Sp. gr. 1·22.

connecting the external H and N with the galvanometer was at first powerful, but soon ceased altogether, to reappear after breaking contact, and again establishing connection.

My next experiments were performed with the object of producing a more powerful polarisation of the nitrogen, if possible, by taking advantage of the current produced by H and O in Grove's gas battery.

I made one or two preliminary experiments with hydrogen and oxygen gases themselves in Grove's gas battery, which brought out some interesting analogies and differences between the behaviour of these gases and that of nitrogen and hydrogen when placed in similar circumstances.

Thus it soon became evident that the rapidity of contraction, and the strength of current produced by H and and O are alike influenced by the conductivity of the acid in the cell, as is the case with H and N. In a cell filled with equal volumes of strong sulphuric acid and water, the contraction of H and O was very slow, and the deflection produced on first making contact with the galvanometer was only 3°. Permanent deflection 1°.

When the same gases were confined over dilute H_2SO_4, of sp. gr. 1·22 (best conductor), however, not only was the contraction of the gases much more rapid, but also the first deflection amounted to 60°, whilst the needle was permanently deflected through an angle of 11° on leaving

the tubes in contact. As in the case of nitrogen and hydrogen, the current observed on first making contact with the galvanometer rapidly diminishes in force in the case of H and O, but with these gases a *permanent deflection* is observed on leaving the plates in contact with the galvanometer, which nitrogen and hydrogen seem to be incapable of producing.

To be continued.)

A TEST FOR TIN.

By CHARLES R. DRYER, M.D.

THE reaction between stannous chloride and a solution of brucia in nitric acid is well known to chemists; but, as far as the writer is aware, it has hitherto been used only for the detection of brucia and not as a test for tin. For the latter purpose it possesses several advantages over the ordinary test with mercuric chloride. It is more delicate, more striking, more convenient, and may be applied under conditions where the latter test cannot.

Brucine Reagent.—To 1 decigrm. of crystallised brucia add 1 c.c. of pure nitric acid; when solution is complete, add 50 c.c. of water, heat to boiling, and cool. The heating is not necessary, but renders the reagent somewhat more sensitive. It is of a permanent orange-amber colour.

Use.—In the ordinary course of analysis the sulphides of arsenic, antimony, and tin are obtained upon a filter, and are digested with ammonium carbonate for the removal of arsenic. The residue is dissolved in strong hydrochloric acid, the solution evaporated, diluted with water, and a strip of platinum and a strip of zinc placed in it in contact for several hours. Nascent hydrogen reduces antimony chloride to metal, which is deposited upon the platinum, and stannic chloride to stannous chloride, which remains in solution. Now, if to a few drops of the brucine reagent in a white dish a drop of the solution containing stannous chloride be added, a distinct purple colour is produced.

Interference.—Neither zinc chloride nor nascent hydrogen produces any effect upon the reagent. Organic matter does not interfere. Ammonium sulphide and sodium hyposulphite act like stannous chloride.

Delicacy and Limits.—By using a solution of stannous chloride repeatedly diluted, it was found that a drop containing only 0·0000025 grm. gave a distinct colour after about one minute. A drop containing 0·00002 grm. gave a barely perceptible cloudiness with mercuric chloride.

If the reagent be too dilute, the colour is pale and the reaction indistinct. If excess of brucia be used no purple colour is produced, but a dirty green or a decolouration resembling the morphia reaction.

Fort Wayne, Indiana, U.S.A.,
Nov. 1, 1883.

DETERMINATION OF THE ATOMIC WEIGHT OF NICKEL BY MEANS OF ITS SULPHATE.

By M. H. BAUBIGNY.

Preparation of the Sulphate.—The commercial nitrate is dissolved in ammonia mixed with a little ammonium carbonate, and the precipitate, especially the oxide of iron, is filtered off; then, having expelled the greater part of the ammonia by means of heat, the liquid is neutralised with sulphuric acid and the double sulphate which separates is collected. This salt, after being purified by several crystallisations, is finally transformed into nickel sulphate mixed with a little oxide by heating it to dull redness in an open muffle. If the pulverised product is treated with cold water, in which anhydrous nickel sulphate dissolves but slowly, the sulphates of copper and zinc dissolve in great part if they still exist in appreciable quantity. In any case the last traces of these metals are entirely separated if we saturate *in the cold* with hydrogen sulphide the solution of nickel sulphate (operating at the end with the aid of boiling water) *previously* mixed with sufficient glacial acetic acid to hinder the precipitation of the nickel.

When the sulphides have been filtered off the solution is evaporated to dryness after being acidified with a little nitric acid to prevent the formation of nickel sulphide under the influence of heat. The sulphate is calcined and the oxide dissolved in nitric acid. If, according to Fischer's method, we then add a large excess of potassium acetate to sodium nitrite, the liquid, after eight to ten days, no longer contains a perceptible quantity of cobalt.

By combining this mode of separation with Langier's method, *i.e.*, crystallising in ammonia the nickel oxalate derived from the separated solution of the double cobalt and potassium nitrite, and evaporated with hydrochloric acid to decompose the excess of alkaline nitrite and acetate, the author has obtained nickel absolutely free from cobalt; at least the most careful analysis has not enabled him to find the slightest trace of cobalt. The oxalate is calcined, the resulting oxide is washed in water, taken up in sulphuric acid, and the sulphate is dried at 440°.

Lastly, as final purification, this nickel sulphate is converted into a crystalline sulphide in an acid liquid. For this purpose about 70 grms. of the sulphate are dissolved in a litre of water and saturated with sulphuretted hydrogen at the temperature of the atmosphere. The liquid is let settle for half an hour, the air being excluded, and the small quantity of sulphide formed is filtered off. The liquid which is slightly acidulated by the acid which has been set free is then heated to 100° in a closed vessel after having been again saturated with hydrogen sulphide. The nickel sulphide formed is absolutely pure, free from every other metal; it is dense, crystalline, and unalterable in the air. The mother-liquor, still rich in nickel, is decanted, evaporated to dryness to expel the bulk of the free acid, and the sulphate which remains yields a second portion of crystalline sulphide. These two sulphides then washed and dissolved, each separately in aqua-regia, furnish on evaporating their solutions with an excess of sulphuric acid the two sulphates which have served for the author's determinations. They were taken up in hot water, filtered, and allowed to crystallise.

Nickel sulphate retains energetically the last traces of free sulphuric acid, even at 440°. This is indicated by the sensible differences found for the equivalent when the action of heat has not been sufficiently prolonged. There is every reason to believe that this is due to a physical fact—to certain influences of capillarity not prevented by copper and zinc sulphates.

a. First Sulphate.—To discover easily small losses of weight it was heated by periods of 12 hours until the weight was constant, the loss during this time not exceeding 1—2 milligrms. After 60 hours the weight no longer varied, and was found to be 6·2605 grms. It was calcined at the temperature of melting gold, with two repetitions for safety. There remained $NiO = 3·0225$ grms., and loss $(SO_3) = 3·238$ grms., whence the atomic weight $Ni = 29·372$ if $S = 16·037$, and $Ni = 29·337$ if $S = 16$.

b. On operating in the same manner with the second sulphate to a constant weight we have $Ni = 29·375$ if $S = 16·037$ and $Ni = 29·340$ if $S = 16$; for 4·4935 grms. of sulphate left 2·1695 grms. of nickel oxide. Whence the mean $Ni = 29·374$ if $S = 16·037$ and $Ni = 29·339$ if $S = 16$.

The oxide of nickel is very stable and does not become peroxidised by the action of the air. It is even known that the saline oxide Ni_3O_4 which the author made known in 1879 is transformed into protoxide by the action of heat. Further, the dissociation tension at the temperature of melting gold is null. This the author has demonstrated, since on heating 1·120 grm. of pure nickel oxide, obtained by the calcination of the sulphate, at the highest temperature of a reverberatory furnace, in an impervious

The statements of Woehler, Liebig, and Laurent, as to the impossibility of decomposing nickel oxide by heat alone, are, therefore, correct.

The author insists upon this point on account of the error of some recent experimentalists who have supported the false notion of the decomposition of nickel oxide into metallic nickel and oxygen at a high temperature, confounding a phenomenon of reduction with one of dissociation, nickel oxide being already reduced at 270° in a reducing atmosphere. The experiment of Wenzell, who first announced this decomposition by heat alone, proves, in fact, absolutely nothing, since he calcined the oxide in an open crucible in the fire of a forge.

The determinations of the equivalent of nickel are numerous; but the results vary from 29 (according to Schneider, Sommaruga, and Lee, who employed complicated methods) to 29·5, the figure generally adopted at present, but in the author's opinion, too high. Erdmann and Marchand by reducing the oxide found about 29·3 and Russell 29·369.

The only attempt by means of the sulphate is due to M. Marignac, but deviations of from 29·2 to 29·5 hindered this *savant* from coming to a conclusion. The cause of this failure must be sought in the difficulty of preparing the normal sulphate.—*Comptes Rendus.*

DETERMINATION OF FREE FATTY ACIDS IN OILS.

By M. G. KRECHEL.

To detect qualitatively the presence of free fatty acids in an oil, the author employs a procedure the principle of which has been indicated by Jacobsen, and which consists in utilising the solubility of the salts of rosaniline in oils containing free fatty acids.

He first prepares a concentrated alcoholic solution of rosaniline acetate; he measures into a test-tube about 10 c.c. of the oil in question, adds to it 5 or 6 drops of the solution of rosaniline, agitates very strongly to ensure thorough mixture, heats in a boiling water-bath for 15 minutes to expel every trace of alcohol, lets settle for twelve hours, and filters. A rose colouration of the filtrate shows that the oil contains a free fatty acid.

The author has endeavoured to utilise these properties of the oils and the fatty acids for the determination of the latter, since a mere qualitative test renders but little service, especially when it is required to find the comparative value of several samples of a lubricating oil containing normally free fatty acids, such as olive oil.

After having ascertained that the power of an oil for dissolving rosaniline salts is proportional to the quantity of fatty acids present, he sought for a liquid which should be at once a good solvent of oils, but incapable of dissolving or decolourising rosaniline acetate. He finally selected rectified petroleum, which seemed to answer completely all the conditions required.

He also sought for an agent capable of altering the colour of the red liquid in a distinct manner, and proportionally to the rosaniline acetate in solution. He employs for this purpose "sulphuric petroleum," the preparation for which is indicated below.

The method of operation finally adopted is as follows:—

Ten c.c. of the oil in question are mixed in a test-tube with 1 c.c. of a concentrated alcoholic solution of rosaniline acetate. The liquids are strongly agitated to effect complete mixture, and the tube is then placed for an hour in a boiling water-bath in order to drive off the last trace of alcohol. It is then washed with rectified petroleum (spec. gr. 800, 0·800?) and the total volume is made up with this liquid to 100 c.c. Of this liquid 10 c.c. are petroleum so as to make up 100 or 120 c.c. "Sulphuric petroleum" prepared as described below is then added drop by drop from a burette, until a distinct change of colour is effected.

The sulphuric petroleum used is thus prepared:—500 c.c. of rectified petroleum are mixed with 100—150 c.c. of sulphuric acid at sp. gr. 1·357. The mixture is stirred from time to time and allowed to react for at least ten days. There is formed a black deposit; the petroleum itself takes a dark colour, but after some time it clears again and gives off a strong odour of sulphurous acid, the action of which probably decolourises the solution of rosaniline acetate. It is decanted and filtered and is ready for use after its value has been established by titration, taking oleic acid as the standard of comparison. To this end a solution is made of 10 per cent oleic acid in an oil which contains no free fatty acid, which must be determined by a preliminary trial. The oils of colza and radish seed before purification are generally in this condition.

The oleic acid must be free from oleine and dissolve entirely in alcohol. This mixture is used for standardising the "sulphuric petroleum." We treat 10 c.c. of the solution of oleic acid in oil with rosaniline acetate; we filter and dilute, after washing as explained above and then standardise the "sulphuric petroleum."—*Journal de Pharmacie et de Chimie.*

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

LITHIUM.

THE earlier determinations of the atomic weight of lithium by Arfvedson, Stromeyer, C. G. Gmelin, and Kralovanzky were all erroneous, because of the presence of sodium compounds in the material employed. The results of Berzelius, Hagen, and Hermann were also incorrect, and need no further notice here. The only investigations which we need to consider are those of Mallet, Diehl, Troost, and Stas.

Mallet's experiments† were conducted upon lithium chloride, which had been purified as completely as possible. In two trials the chloride was precipitated by nitrate of silver, which was collected upon a filter and estimated in the ordinary way. The figures in the third column represent the LiCl proportional to 100 parts of AgCl:—

7·1885 grms. LiCl gave	24·3086 grms. AgCl.	29·606
8·5947 „	29·0621 „	29·574

In a third experiment the LiCl was titrated with a standard solution of silver. 3·9942 grms. LiCl balanced 10·1702 grms. Ag, equivalent to 13·511 grms. AgCl. Hence 100 AgCl = 29·593 LiCl. Mean of all three experiments, 29·581 ± 0·0087.

Diehl,‡ whose paper begins with a good resumé of all the earlier determinations, describes experiments made with lithium carbonate. This salt, which was spectroscopically pure, was dried at 130° before weighing. It was then placed in an apparatus from which the carbon dioxide generated by the action of pure sulphuric acid upon it could be expelled, and the loss of weight determined. From this loss the following percentages of CO_2 in Li_2CO_3 were determined:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Silliman's Amer. Journal*, November, 1856. *Chem. Gazette*, 15, 7.
‡ *Ann. Chem. Pharm.*, 121, 93.

59·422
59·404
59·440
59·401

Mean 59·417 ± 0·006

Diehl's investigation was quickly followed by a confirmation from Troost.* This chemist, in an earlier paper,† had sought to fix the atomic weight of lithium by an analysis of the sulphate, and had found a value not far from 6·5; thus confirming the results of Berzelius and of Hagen, who had employed the same method. But Diehl showed that the $BaSO_4$ precipitated from Li_2SO_4 always retained traces of Li, which were recognisable by spectral analysis, and which accounted for the error. In the later paper Troost made use of the chloride and the carbonate of lithium, both spectroscopically pure. The carbonate was strongly ignited with pure quartz powder, thus losing carbon dioxide, which loss was easily estimated. The subjoined results were obtained:—

0·970 grm. Li_2CO_3 lost 0·577 grm. CO_2. 59·485 per cent.
1·782 ,, 1·059 ,, 59 427

Mean 59·456 ± 0·020

This combined with Diehl's mean, 59·417 ± 0·006, gives a general mean of 59·420 ± 0·0057.

The lithium chloride employed by Troost was heated in a stream of dry hydrochloric acid gas; of which the excess, after cooling, was expelled by a current of dry air, The salt was weighed in the same tube in which the foregoing operations had been performed, and the chlorine was then estimated as silver chloride. The usual ratio between LiCl and 100 parts of AgCl is given in the third column:—

1·309 grms. LiCl gave 4·420 grms. AgCl. 29·615
2·750 ,, 9·300 ,, 29·570

Mean 29·5925 ± 0·0145

This combined with Mallet's mean, 29·581 ± 0·0087, gives a general mean of 59·584 ± 0·0075.

Finally, we come to the work of Stas,‡ which was executed with his usual wonderful accuracy. In three titrations, in which all the weights were reduced to a vacuum standard, the following quantities of LiCl balanced 100 parts of pure silver:—

39·356
39·357
39·361

Mean 39·358 ± 0·001

In a second series of experiments, intended for determining the atomic weight of nitrogen, LiCl was converted into $LiNO_3$. The method was that employed for a similar purpose with the chlorides of sodium and of potassium. 100 parts of LiCl gave of $LiNO_3$:—

162·588
162·600
162·598

Mean 162·5953 ± 0·0025

We have now the following ratios from which to deduce the atomic weight of lithium:—

(1.)	AgCl : LiCl	:: 100 :	29·584	± 0·0075
(2.)	Ag : LiCl	:: 100 :	39·358	0·001
(3.)	LiCl : $LiNO_3$	:: 100 :	162·5953	0·0025
(4.)	Per cent of CO_2 in Li_2CO_3		59·420	0·0057

Hence two values for the molecular weight of LiCl:—

From (1).. .. .. LiCl = 42·3187 ± 0·0039
From (2).. .. .. ,, = 42·3787 0·0111

General mean .. ,, = 42·3720 0·0037

For lithium itself we get three values:—

From molecular weight of LiCl .. Li = 7·002 ± 0·015
From ratio (3) .. .. ,, = 7·0287 0·042
From ratio (4) .. .. ,, = 7·0085 0·008

General mean .. .. ,, = 7·0073 0·007

If O = 16, then Li = 7·0235. Stas himself gives 7·022 as his determination. Difference, 0·0015.

* *Zeit. Anal. Chem.*, 1, 402.
† *Annales de Chim et de Physique*, 51, 108.
‡ Aronstein's Translation, 279—302.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 24, 1883.

Prof. CLIFTON, President, in the Chair.

PROF. REINOLD read a paper by Mr. J. W. CLARK, "*On the Purification of Mercury by Distillation in vacuo.*" The advantages of Mr. Clark's apparatus are the small quantity of mercury in use at a time, and the fact that no auxiliary Sprengel pump is required. This is avoided by having a movable reservoir of mercury, on raising which the distiller is filled with mercury. The apparatus was described in detail, and illustrated by a figure. It is probable that zinc, cadmium, magnesium, &c., may be distilled, and thus purified by the same apparatus.

Mr. A. P. CHATTOCK then read a paper "*On a Method of Determining Experimentally the Constant of an Electro-Dynamometer.*" In existing methods it is necessary to measure the areas of the coils, which is a difficult matter to do with a finished instrument: by the new method this is unnecessary. It depends on the accurate determination of the speed of the movable coil. Mr. Chattock exhibited an instrument whose constant had been determined by him in the laboratory of Prof. Foster, University College, with the assistance of Mr. Grant.

Professor G. C. FOSTER then took the chair, and

Professor R. B. CLIFTON (President) read a paper "*On the Measurement of the Curvature of Lenses.*" With very small lenses the spherometer cannot be used, and the author's method is based on the Newton's rings formed between the lens and a plane surface or a curved surface of known radius. From the wave-length of the light employed in observing, and the diameter of a ring, the radius of curvature can be determined. He places the lens on a plane or curved surface under a microscope, and lights it by the sodium flame (wave-length 5892×10^{-7}). He measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length and the number of rings in the gap between to find the radius of the lens. The formula is—

$$\rho^1 m\lambda = \left(x^2_{m+n} - x^2_n\right)$$

where x_{m+n} and x_n are the diameters of the nth and $(m+n)$th rings, and λ is the wave-length of the light, and ρ^1 the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in small quantities, Mr. Richardson having found it for water = 1·3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical.

Professor PERRY suggested that it might be also used to measure a surface without touching it; say the surface of a water drop or a strip of glass when bent. In this way it might throw light on the laws of capillarity or of bending.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 19, November 5, 1883.

New Aperiodic Galvanometer.—G. Le Goarant de Tromelin.—The instrument in question has six poles formed by three horseshoe magnets with limbs very close together. These three fixed magnets are placed horizontally, one above the other, at a distance of 0·005 metre. The frame encloses the two poles of the middle magnet, leaving play-room sufficient to permit it to oscillate freely and to obtain 20 degrees of deviation on each side. The wire of this small and very light frame is perpendicular to the axis of the magnets, and the current arrives there by a suspension wire, as in Sir W. Thomson's syphon-recorder. If this galvanometer is connected with the two ends of a telephone from which the vibrating plate has been removed, the mere fall of a fragment of iron-filing, weighing a few milligrammes, upon the pole of the magnet of the telephone is sufficient to cause a deviation of the frame.

Electric Resistance of certain Insulating Substances.—G. Foussereau.—The author has studied the resistance of sulphur and phosphorus in different conditions.

Influence of Sodium Nitrate and Potassium Nitrate upon the Cultivation of Potatoes.—P. P. Dehérain.—In the author's experiments the nature of the base combined with the nitric acid did not modify the results. The sodium nitrate is converted into potassium nitrate at the expense of the salts of potassium present in the soil. Hence it is only in soils poor in potash that potash-saltpetre gives results superior to those obtained with soda-saltpetre. The potato does not, however, assimilate salts of soda.

Researches on the Physiological Properties of Maltose.—E. Bourquelot.—The author has examined the action of digestive ferments and of the acids of the human economy upon maltose.

External Use of Metallic Copper as a Preservative against Cholera.—Alex. Lamm.—The author suggests that the immunity from cholera enjoyed by certain places where copper-mining and smelting are carried on is due not so much to the metal as to the sulphurous acid, which he states is given off at Fahlun in intolerable quantities.

Comparative Poisonous Action of Metals upon the Microbia.—Ch. Richet.—To obtain the microbia the author used sea-water in which a small quantity of peptone had been dissolved. This liquid rapidly swarms with microbia. He found the metals fatal to microbia in the following order:—Mercury, zinc, cadmium, copper, nickel, iron (ferric salts), barium, lithium, magnesium, manganese, ammonium, calcium, sodium, and potassium. The poisonous dose for bacteria is in general about twenty times greater than for fishes. The author points out the extremely poisonous character of ammonium and potassium for fishes, whilst towards microbia they are comparatively inert.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., Sept., 1883.

Determination of Carbon Disulphide in the Sulpho-carbonates.—M. A. Müntz.—Already noticed.

Contribution to the Chemical Theory of Secondary Batteries.—Prof. E. Frankland.—From the *Proceedings of the Royal Society.*

Cosmos les Mondes.

No. 8, October 20, 1883.

This number is taken up with abstracts and selections from the travels of J. B. Tavernier in Tonkin.

No. 9, October 27, 1883.

This number contains no chemical matter.

MEETINGS FOR THE WEEK

MONDAY, Dec. 3rd.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Chemical Industry. "On a New Residual Product from Coal-gas," by H. L. Greville. "Further Notes on the Stassfurt Industry," by C. N. Hake. Drs. Raydt and Kunheim's Liquid Carbonic Acid Apparatus, exhibited by A. Zimmerman.
—— Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.
TUESDAY, 4th.—Institute of Civil Engineers, 8.
—— Pathological, 8.30
WEDNESDAY, 5th.—Society of Arts, 8. "The Manufacture of Mineral Waters," by Thomas T. P. Bruce Warren.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 6th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— London Institution, 7.
—— Chemical, 8. Ballot for the Election of Fellows. "On the Constitution of the Fulminates," by Dr. Divers and M. Kawakita, M.E. "On Liebig's Production of Fulminating Silver without the Use of Nitric Acid," by Dr. Divers and M. Kawakita, M.E. "Note on the Constitution of the Fulminates," by Dr. H. E. Armstrong, F.R.S. "Experimental Investigation on the Value of Iron Sulphate as a Manure for certain Crops," by A. B. Griffiths.
—— Parkes Museum, 8 p.m. Lecture by Dr. G. V. Poore, on "Coffee and Tea."
SATURDAY, 7th.—Physical, 3. "On the Static Telephone as an Instrument of Research; On a New Insulating Support; and On the First Law of Electrostatics," by Prof. S. P. Thompson. "Experiments Illustrating the Attraction and Repulsion of Bodies in Motion," by J. Monckmann, D.Sc. "An Integrating Anemometer," by Walter Baily.

Wanted, by a Coal-Tar Colour Manufacturer, a Chemist for the Laboratory. One who has worked on cresol and its derivatives will find preference.—Address, "Beta," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, Situation by Chemist (25) well up in manufacture of nitric, sulphuric, pure muriatic, fluoric acids &c.; sulphide, bisulphite, hyposulphite of soda, oxalates, baryta and strontia salts, pure alumina.—W. B., 4, Stanraer Place, Maida Vale, W.

Wanted.—"Researches on the Solar Spectrum and the Spectra of the Chemical Elements," by G. Kirchhoff. (*First part.*) Translated by Prof. Roscoe.—Address, H.E., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, in a small Chemical Works near London, an Assistant for the Laboratory, having some chemical knowledge.—State previous occupation, age, and salary required, to S. A. P., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, the Makers' Names of the following: Chloride of Magnesium, Chloride of Zinc, and Soluble Oil.—Address, "Chloride," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

An Old-established Manufacturing Chemical Business for Disposal.—The Plant and Machinery are constructed on the most improved principle, and are in good and substantial condition, for the distillation and manufacture of products from gas-tar and ammoniacal water, comprising, amongst other articles, naphthalene, anthracene, paraffin wax and spirits, creosote for preserving wood, lubricating oils and compounds, railway, tram, and machinery greases, varnishes, &c. There is also the necessary plant for the manufacture of lithographic inks. The premises are compact, and well situate for shipping, with private siding into the L. & N. W. Railway, with ample land for any extension of works. Capital required, about £12,000. As there is an efficient staff, a previous knowledge of the business not actually necessary.—For further particulars, principals or their solicitors, apply to Thos. Green, Esq., Wold House, Hawarden, near Chester.

THE CHEMICAL NEWS.

Vol. XLVIII. No. 1254.

ON A "RENNET" FERMENT CONTAINED IN THE SEEDS OF WITHANIA COAGULANS.*

By A. SHERIDAN LEA, M.A., Trinity College, Cambridge.

The Report of the Royal Gardens at Kew for 1881 contains abstracts of correspondence, in which it was pointed out that, in order to introduce a cheese-making industry in India, some vegetable substitute must be found for the ordinary animal rennet, since cheese made with the latter is unsaleable among the natives. In response to the above "Surgeon-Major Aitchison brought to the notice of the authorities at Kew that the fruit of *Puncteria*† *coagulans*, a shrub common in Afghanistan and Northen India, possesses the properties of coagulating milk;" and experiments showed that an aqueous extract of the seed-capsules of the above plant does somewhat rapidly coagulate milk.

I was recently requested to make some experiments on the seeds of Withania to determine whether they contain a definite ferment with the properties of ordinary rennet and the applicability of such a ferment to cheese-making purposes.

The material supplied to me consisted of an agglomerated dry mass of seed-capsules and fragments of the stalks of the plant. When crushed in a mortar the whole crumbled down into a coarse powder, in which the seeds were for the most part liberated from the capsules. I picked out the larger pieces of stalk, sifted out the finer particles, chiefly earth and fragments of the capsules, and then by a further sifting I separated the seeds from the other larger particles. The seeds appeared to be each enveloped in a coating of resinous material, presumably the dried juice of the capsules in which they had ripened.

Taking equal weights of the seeds, I extracted them for twenty-four hours with equal volumes of (i.) water, (ii.) 5 per cent sodic chloride, (iii.) 2 per cent hydrochloric acid, (iv.) 3 per cent sodic carbonate. Equal volumes of each of the above were added in an an acid, alkaline, and neutral condition, to equal volumes of milk, and heated in a water-bath at 38° C. The milk was rapidly coagulated by the salt and sodic carbonate extracts, much less rapidly by the other two; of the four, the salt extract was far the most rapid in its action. All subsequent experiments have shown that a 5 per cent solution of sodic chloride is the most efficient in the extraction of the active principle from the seeds.

There is no doubt that the substance which possesses the coagulating power is a ferment closely resembling animal rennet.

I. A portion of the 5 per cent sodic chloride extract loses its activity if boiled for a minute or two.

II. The active principle is soluble in glycerin, and can be extracted from the seeds by this means; the extract possesses strong coagulating powers even in small amounts.

III. Alcohol precipitates the ferment body from its solutions; and the precipitate, after washing with alcohol, may be dissolved up again without having lost its coagulating powers.

IV. The active principle of the seeds will cause the coagulation of milk when present in very small quantities, the addition of more of the ferment simply increasing the rapidity of the change.

V. The coagulation is not due to the formation of acid by the ferment. If some of the active extract be made neutral or alkaline and added to neutral milk, a normal clot is formed, and the reaction of the clot remains neutral or faintly alkaline.

VI. The clot formed by the action of the ferment is a true clot, resembling in appearance and properties that formed by animal rennet, and is not a mere precipitate.

Having thus determined the presence of a rennet ferment in the seeds, I endeavoured to prepare an active extract, which should be applicable for cheese-making purposes. All the extracts of the seeds are of a deep-brown colour, and it appeared therefore, in the first place, desirable to obtain less highly coloured, if not colourless, solutions, which should still be active. In this I have so far failed. The precipitate caused by alcohol carries down the chief part of the colouring matter also, so that on being subsequently re-dissoived the solution is nearly as highly coloured as before the precipitation. The colour can be removed by using animal charcoal, but the ferment is at the same time destroyed. If all excess of charcoal is avoided and the solution is filtered at once, the filtrate is largely decolourised, but contains only traces of the ferment. Animal rennet is similarly removed by filtration through charcoal. The colour can be removed by the addition of very finely-powdered kaolin in a dry state, but, as before, the ferment activity is thereby destroyed. The same holds good of animal rennet. The colouring-matter is scarcely soluble in either ether or alcohol, so that no advantage is gained by a preliminary treatment with these before extraction with the salt solution. I have also endeavoured to get rid of the colour by treating the seeds as rapidly as possible with successive quantities of water before making the final extract. By using a centrifugal machine I was able to wash the seeds six or seven times with large volumes of water without their being exposed for any considerable time to the action of the water. Each portion of water was highly coloured and the seeds were thus freed from adherent colouring-matter. But, apart from the fact that some, though not much, ferment is thus lost, no special advantage is obtained, since the seeds are themselves coloured, and even after prolonged treatment with water the final extract is always of a dark brown colour.

In order to obviate the disadvantages of this colouring matter, if disadvantage it is, I have found it best to prepare very concentrated active extracts of the purified seeds, so that it should only be necessary to add a very small quantity of the extract in order to coagulate the milk and obtain a colourless curd. This I have done by grinding the dry seeds very finely in a mill and extracting them for twenty-four hours with such a volume of 5 per cent sodic chloride solution that the mass is still fluid after the absorption of water by the fragments of the seeds as they swell up. From this mass the fluid part may be readily separated by using a centrifugal machine (such as is used in sugar refining), and it can then be easily filtered through filter-paper. Without the centrifugal machine the separation of the fluid from the residue of the seeds is tedious and imperfect; 40 grms. of the seeds treated as above with 150 cub. centims. of 5 per cent sodic chloride solution gave an extract of which 0·25 cub. centim. clotted 20 cub. centims. of milk in twenty-five minutes, and 0·1 cub. centim. clotted a similar portion of milk in one hour. When added in these proportions the curd formed is quite white. The presence of the colouring-matter is, however, perhaps on the whole unimportant, since even a larger quantity of the ferment extract is added in order to obtain a very rapid coagulation the colouring-matter is obtained chiefly in the whey, the curd being white.*

The question of preparing an extract which should be capable of being kept for a considerable time is perhaps of importance. Ordinary commercial rennet usually contains a large amount of sodic chloride and some alcohol. One specimen I analysed contained 19 per cent of common salt, and 4 per cent of alcohol. I have, therefore, added

* A paper read before the Royal Society, Nov. 22, 1883.

† The genus Puncteria is now reduced by botanists to Withania.

* It is extremely probable that some stage in the growth of ripening of the seeds of Withania might be found at which the development of colouring-matter is slight, while at the same time the ferment is present in considerable quantity.

to the 5 per cent chloride extract mentioned above, enough salt to raise the percentage of this to 15 per cent, and also alcohol up to 4 per cent. The activity of the extract is not appreciably altered by this, and such a preparation corresponds very closely in activity with a commercial solution of animal rennet with which I compared it. The possibility of making extracts which may be expected to keep is thus indicated, but of course time alone will show whether the activity of the ferment is impaired to any important extent by such keeping.

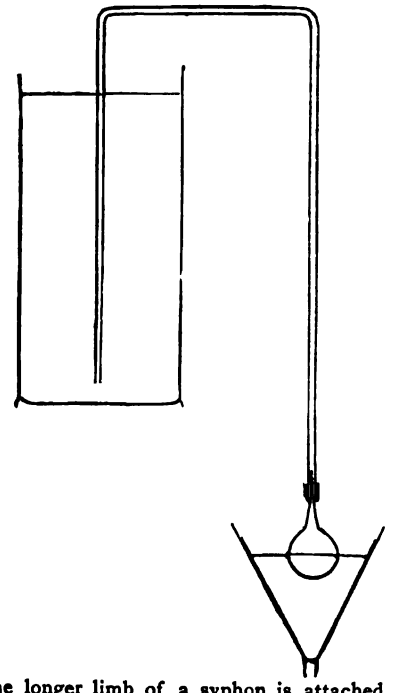
I may add in conclusion that I have coagulated a considerable volume of milk with an extract such as I have described, and prepared a cheese from the curds. I have also given a portion of the extract to a professional cheesemaker, who has used it as a substitute for animal rennet in the preparation of a cheese. The product thus obtained, and the statements of the person who has made the experiment for me, led me to suppose that extracts of the seeds of Withania can be used as an adequate and successful substitute for animal rennet.

AUTOMATIC FILTRATION.

By E. E. ROBINSON.

WHEN large quantities of liquids, such as reagents, have to be filtered in the laboratory, it is often convenient to have some means by which the filter is kept filled. The usual "bird-fountain" method which is applicable in some cases, has the disadvantage of requiring the inverting of large bottles or flasks filled with liquid, and besides this it does not maintain the liquid at a constant level in the filter.

The following apparatus has been found more convenient:—



To the longer limb of a syphon is attached a short piece of india-rubber tube projecting a little beyond the tube, the india-rubber is closed by the narrow conical stem of a small glass globe which floats on the surface of the liquid in the funnel; when the liquid rises to a certain height the float is lifted, and stops the flow of the liquid, the narrow stem on the float which passes some distance into the syphon acting as a guide.

The apparatus keeps the liquid in the funnel at a constant level, and may be left without attention until the filtration is complete.

Chemical Laboratory, Cooper's Hill,
November, 1883.

ON THE SEPARATION OF COBALT AND NICKEL.

By JOHN CLARK, Ph.D., F.C.S., F.I.C.

IN 1879, M. Ph. Dirvell published a process for the separation of nickel and cobalt (CHEMICAL NEWS, vol. xl., p. 268), based upon the precipitation of the cobalt as ammonio cobaltic phosphate by means of microcosmic salt and bicarbonate of ammonia, prepared by saturating effloresced carbonate of ammonia with carbonic acid till all ammoniacal smell was gone. In carrying out the process, he added to an aqueous solution of the nitrates or sulphates of cobalt and nickel a quantity of a cold saturated solution of microcosmic salt equal to thirty times the weight of the two metals, and a volume of bicarbonate of ammonia equal to that of the microcosmic salt. The mixture was then slowly heated till the equivalent of carbonic acid in excess escaped, ammonia added to dissolve this precipitate, and the solution heated till the ammonio-cobaltic phosphate separated as a precipitate of a beautiful purple colour inclining to violet. This precipitate was found by analysis to have the composition—$(NH_4O,2CoOPO_5+2HO) = CoNH_4PO_4+H_2O$, and by ignition it is converted into the pyrophosphate of cobalt, $Co_2P_2O_7$. The nickel remains in solution, communicating to it a clear blue colour, and is only precipitated after protracted boiling. Dirvell states, further, that M. Pisani, in whose laboratory his experiments were made, had found that acetate of ammonia could be used instead of the bicarbonate of ammonia, and he gives certain directions for ascertaining approximately the proportions of cobalt and nickel from the colour of the solution.

So far as I am aware Dirvell has not published any of the results which he obtained by this method, and in endeavouring to carry out the process in the manner described, I found that when microcosmic salt and bicarbonate of ammonia were employed it was very difficult to precipitate the whole of the cobalt, and sometimes I failed to precipitate even a portion of it. With the acetate of ammonia and microcosmic salt the process worked better, but still in my experience unsatisfactorily. It appeared to me, nevertheless, that the process might be improved, and with that object I made a number of experiments, in the course of which I found:—

1. That phosphate of ammonia was the most suitable substance for precipitating the cobalt, but ordinary phosphate of soda can also be used.

2. In estimating the cobalt it is not necessary to use either bicarbonate of ammonia or acetate of ammonia, as chloride of ammonium, sulphate of ammonia, and nitrate of ammonia do as well as the acetate, and better than the bicarbonate.

3. In the case of phosphate of ammonia it is only necessary to use a little more than what is theoretically required to precipitate both cobalt and nickel as phosphate, but when phosphate of soda is employed a larger quantity seems to be necessary.

4. I have confirmed the correctness of the formula given by Dirvell to the ammonio-cobaltic phosphate.

Process.

In separating cobalt from nickel I proceed as follows:—The solution containing the two metals in the form of chlorides, nitrates, or sulphates is mixed with a moderate excess of phosphate of ammonia (about five times the

weight of the combined cobalt and nickel is sufficient), and for every part of phosphate of ammonia about 5 parts of ordinary hydrochloric acid are added, and the mixture is boiled for several minutes to make sure that all the phosphoric acid is in the state of ortho-phosphoric acid; the beaker or other vessel is then removed from the flame, and while still nearly boiling ammonia is added cautiously, in small quantities at a time, till the precipitate, which is at first produced, re-dissolves. The solution is then stirred vigorously for about a minute, when the cobalt will separate out as a fine purple crystalline powder, consisting of ammonio-phosphate of cobalt. About 10 drops of ammonia are then added, and the beaker placed for a few minutes on the top of a water-bath. When the precipitate has settled it is thrown upon a filter, washed with cold water, dried, ignited, and weighed as pyrophosphate of cobalt, $Co_2P_2O_7$, containing 40·4 per cent of cobalt. The filtrate from the cobalt will be more or less of a clear blue colour, the intensity depending on the quantity of nickel present. As the filtrate usually contains a small quantity of cobalt, it is advisable to heat it at 100° C. till a small quantity of the nickel begins to come down. If the whole of the cobalt has been thrown down, this precipitate will be green in colour, but if there was any cobalt in the solution it will be more or less red. In any case, it is filtered off, dissolved in hydrochloric acid, and any cobalt which it may contain is estimated as before, and the filtrate, which contains nickel, is added to the other nickel filtrate. The nickel may then be precipitated by saturating the ammoniacal solution with H_2S, filtering off the sulphide of nickel, igniting, then dissolving in nitro-hydrochloric acid, precipitating with caustic potash, and weighing as oxide.

The following experiments were made for the purpose of testing the accuracy of this process, and as there is nothing new in the method of determining the nickel, I have confined myself for the most part to the estimation of the cobalt :—

Expt.	Cobalt taken. Grains.	Nickel taken. Grains.	Weight of Pyrophosphate of Cobalt. Grains.	Cobalt found. Grains.	Nickel found. Grains.
I.	2·94	1·8	7·52	3·05	—
II.	2·94	1·8	7·28	2·94	—
III.	1·83	2·0	4·96	1·89	—
IV.	4·20	4·0	10·49	4·23	—
V.	3·67	0·5	9·09	3·67	0·53
VI.	4·20	0·2	10·38	4·19	0·23
VII.	0·18	2·0	0·45	0·18	—

An experiment in which sulphuric acid was used instead of hydrochloric acid gave the following result :—

Cobalt taken.	Nickel taken.	Wt. of Pyrophosphate of Cobalt.	Cobalt found.	Nickel found.
2·94 grs.	2·1 grs.	7·30 grs.	2·95 grs.	—

With nitric acid instead of hydrochloric acid the following result was obtained :—

Cobalt taken.	Nickel taken.	Wt. of Pyrophosphate of Cobalt.	Cobalt found.	Nickel found.
2·94 grs.	1·0 gr.	7·35 grs.	2·97 grs.	—

In addition to the above experiments, I have made a great many estimations of cobalt and nickel in cobalt ore by this process, and I am satisfied that it yields accurate and reliable results, not only with large quantities of cobalt in presence of small quantities of nickel, but also with small quantities of cobalt in presence of large quantities of nickel. I may mention that I have had occasion to submit this process to several chemists, to be used in the valuation of cobalt ores, and after trial they have admitted that they were satisfied with its accuracy. I may also add that it has been in constant use in a cobalt work for about a year, and that the chemist of the work, after comparative trials, has discarded the other processes in its favour.

In estimating cobalt and nickel in ores, I prefer to precipitate these metals as sulphides in an acetic acid solution. Great care requires to be taken to eliminate manganese, as that metal interferes with the correct estimation of the cobalt. The mixed sulphides, after ignition, are weighed for the purpose of ascertaining approximately the quantity of cobalt and nickel. They are then dissolved in nitro-hydrochloric acid, and the cobalt estimated in the manner already described.

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH KLARKE, S.B.
Chief Chemist to the U.S. Geological Survey, Washington.

RUBIDIUM.

The atomic weight of rubidium has been determined by Bunsen, Piccard, and Godeffroy; but only from analysis of the chloride.

Bunsen,† employing ordinary gravimetric methods, estimated the ratio between AgCl and RbCl. His rubidium chloride was purified by fractional crystallisation of the chloroplatinate. He obtained the following results, to which, in a third column, I add the ratio between RbCl and 100 parts of AgCl :—

1 grm. RbCl gave	1·1873 grms.	AgCl.	84·225
,,	1·1873	,,	84·225
,,	1·1850	,,	84·388
,,	1·1880	,,	84·175

Mean 84·253 ± 0·031

The work of Piccard‡ was similar to that of Bunsen. In weighing, the crucible containing the silver chloride was balanced by a precisely similar crucible in order to avoid the correction for displacement of air. The filter was burned separately from the AgCl, as usual; but the small amount of material adhering to the ash was reckoned as metallic silver. The rubidium chloride was purified by Bunsen's method. The results, expressed according to the foregoing standard, are as follows :—

1·1587	RbCl =	1·372	AgCl +	0·0019	Ag. 84·300
1·4055	,,	1·6632	,,	0·0030	,, 84·303
1·001	,,	1·1850	,,	0·0024	,, 84·245
1·5141	,,	1·7934	,,	0·0013	,, 84·313

Mean 84·290 ± 0·0105

Godeffroy,‖ starting with material containing both rubidium and cæsium, separated the two metals by fractional crystallisation of their alums, and obtained salts of each spectroscopically pure. The nitric acid employed was tested for chlorine and found to be free from that impurity, and the weights used were especially verified. In two of his analyses of RbCl the AgCl was handled by the ordinary process of filtration. In the other two it was washed by decantation, dried, and weighed in a glass dish. The usual ratio is appended in the third column :—

1·4055 grms.	RbCl gave	1·6665	AgCl.	84·338
1·8096	,,	2·1461	,,	84·320
2·2473	,,	2·665	,,	84·326
2·273	,,	2·6946	,,	84·354

Mean 84·3345 ± 0·0051

Combining the three series, we get the following result :—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Zeit. Anal. Chem.*, 1, 136. *Poggend. Annal.*, 13, 339. 1861.
‡ *Journ. f. Prakt. Chem.*, 86, 454. 1862. *Zeit. Anal. Chem.*, 1, 518.
‖ *Ann. Chem. Pharm.*, 181, 185. 1876.

General mean	84·324	0·0045

Hence Rb = 85·251 ± 0·018. If O = 15, Rb = 85·529.

The following additional note has been communicated by the author.—

Since the foregoing calculations were published, new determinations of the atomic weight of Rb have been made by Heycock (*Nature*, xxvi., 467). He titrated silver against the chloride of and bromide of rubidium, after Stas's method, and calculates the following values:—

From RbCl . . . . . Rb = 85·344.
From RbBr . . . . . ,, = 85·387.

The detailed weighings are not given. Probably, in calculation, Stas's values for Ag, Cl, and Br were used. —F. W. C.

CÆSIUM.

The atomic weight of cæsium, like that of rubidium, has been determined from the analysis of the chloride. The earliest determination by Bunsen,* was incorrect, because of impurity in the material employed.

In 1863 Johnson and Allen published their results.† Their material was extracted from the lepidolite of Hebron, Maine, and the cæsium was separated from the rubidium as bitartrate. From the pure cæsium bitartrate cæsium chloride was prepared, and in this the chlorine was estimated as silver chloride by the usual gravimetric method Reducing their results to the convenient standard adopted in preceding chapters, we have, in a third column, the quantities of CsCl equivalent to 100 parts of AgCl:—

1·8371	grm. CsCl gave	1·5634	grms. AgCl	117·507
2·1295	,,	1·8111	,,	117·580
2·7018	,,	2·2992	,,	117·511
1·56165	,,	1·3302	,,	117·399

Mean 117·499 ± 0·025

Shortly after the results of Johnson and Allen appeared a new series of estimations was published by Bunsen.‡ His cæsium chloride was purified by repeated crystallisations of the chloroplatinate, and the ordinary gravimetric process was employed. The following results represent, respectively, material thrice, four times, and five times purified:—

1·3835	CsCl gave	1·1781	AgCl.	Ratio, 117·435
1·3682	,,	1·1644	,,	117·503
1·2478	,,	1·0623	,,	117·462

Mean 117·467 ± 0·013

Godeffroy's work‖ was, in its details of manipulation, sufficiently described under rubidium. In three of the experiments upon cæsium the silver chloride was washed by decantation, and in one it was collected upon a filter. The results are subjoined:—

1·5825	CsCl gave	1·351	AgCl.	Ratio, 117·135
1·3487	,,	1·1501	,,	117·265
1·1880	,,	1·0141	,,	117·148
1·2309	,,	1·051	,,	117·107

Mean 117·164 ± 0·023

We may now combine the three series to form a general mean:—

General mean ..	117·413	3·010

Hence Cs = 132·583 ± 0·024; or, if O = 16, Cs = 132·918.

* *Zeit. Anal. Chem.*, 1, 137.
† *Amer. Journ. Sci. and Arts*, (2.) 35, 94.
‡ *Poggend. Annal.*, 119, 1. 1863.
‖ *Ann. Chem. Pharm.*, 181, 185. 1876.

ELECTRO CHEMICAL RESEARCHES ON NITROGEN.

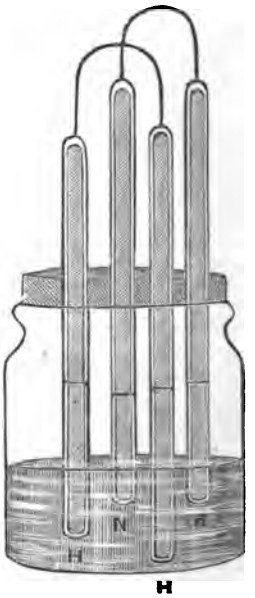
By GEORGE STILLINGFLEET JOHNSON.

(Concluded from p. 257).

Experiments in which Hydrogen, Oxygen, and Nitrogen Gases in Grove's Gas Battery were simultaneously employed.

Two cells were filled with dilute sulphuric acid (sp. gr. 1·220), the tubes in each being respectively charged with hydrogen and oxygen gases. A third cell contained dilute hydrochloric acid (sp. gr. 1·100), and its tubes were charged with nitrogen and hydrogen gases. Connections were made between the hydrogen plate of the first cell and the oxygen one of the second, between the hydrogen plate of the second and the nitrogen plate of the third, and between the hydrogen plate of the third and the oxygen plate of the first, as shown in the accompanying diagram. (Fig. 3.)

FIG. 3.



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In *Cell I.* the platinum plates were 10 inches in length. The oxygen gas in this cell surrounded 5·8 inches of the plate, the remaining 4·2 inches being immersed in the acid; whilst the hydrogen at first occupied 5·9 inches of the adjacent plate.

In *Cell II.* the plates 9 inches long, the oxygen surrounding 6·5, and the hydrogen 6·6 inches of their respective plates.

In *Cell III.* the plates measured 8·8 inches in length, of which the nitrogen covered 6·2 and the hydrogen 6·1 inches at the commencement of the experiment, the remainder of the plates being immersed in the hydrochloric acid. Contact was made between the plates with thick copper wire.

The first observation made was that the contraction of

the hydrogen and oxygen gases was much slower when the cells containing them were included in the same circuit with a cell containing nitrogen and hydrogen, and also the electric current passing from H to O was greatly enfeebled by the presence of the H and N in the same circuit.

For the first two hours, the nitrogen contracted alone very slightly. After forty-eight hours, the hydrogen in all three cells had contracted, so that the acid stood 1·5 inches higher in each hydrogen tube than at the commencement of the experiment. The oxygen in Cells I. and II. had undergone a contraction exactly half that of the hydrogens, whilst the gaseous contents of the nitrogen tube were increased, so that the acid stood at a level 0·7 inch lower in this tube than it had originally done.

A second experiment was made in which the same cells, the same platinum plates, and the same acids were employed, contact being made exactly as above described, and with the same copper wires.

In this experiment 5·2 inches of the oxygen plate of *Cell I.* was in gas, 4·8 inches of the adjacent plate being in hydrogen.

In *Cell II.* oxygen covered 5·9 inches of its plate, whilst 5·5 inches of the adjacent plate stood in hydrogen.

In *Cell III.* pure nitrogen occupied 3·1 inches of the left-hand plate, whilst the other plate was immersed in hydrogen to the length of 5·9 inches.

At first the nitrogen and hydrogen in Cell III. began contracting steadily in the proportion 1 to 3, the oxygen and hydrogen in Cells I. and II. maintaining a constant volume.

After one hour, however, contraction set in in Cells I. and II., the contraction of the hydrogen in Cell III. being at this time 1-5th of an inch, that of the nitrogen about a third of this amount.

During the next two hours the hydrogen in all three cells very slowly contracted, the oxygens in Cells I. and II. disappearing *half* as rapidly as their associated hydrogens, whilst the nitrogen in Cell III. retained a constant volume.

After twenty-one hours, the hydrogen in Cell III. had contracted 4-5ths of an inch, whilst the nitrogen in this cell had now a volume *equal* to its original one. The hydrogens in Cells I. and II. had each undergone a contraction of *half an inch*, whilst the oxygen in these cells had contracted a quarter of an inch.

After twenty-four hours more, the hydrogen in Cell III. had undergone a further contraction of *one inch*, whilst the nitrogen in this cell had expanded till the level of the liquid in its tube was 4-5ths of an inch lower than at first. A brisk evolution of small bubbles of gas was now seen pouring from the portion of the nitrogen plate immersed in the acid (evolution of hydrogen).

The hydrogen in Cell II. had contracted 9-10ths of an inch, whilst that in Cell I. had undergone a contraction of 4·5ths of an inch. The associated oxygens had each contracted half as much.

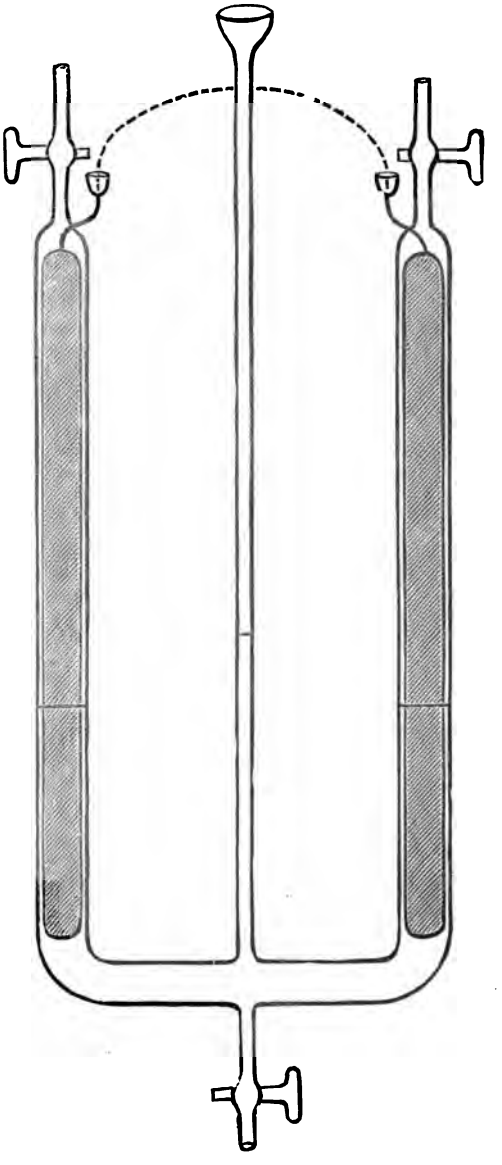
On making contact between the O plate of Cell I. and the H plate of Cell III. and a galvanometer, the first deflection of the needle amounted to 16° from H to O; permanent deflection 6° in the same direction. Cell I. and II. only being in circuit, a primary deflection of 48° was observed from H to O, followed by a permanent deflection of 7° in the same direction.

Experiments with Grove's Gas Battery in which Four Tubes were placed in One Cell.

I next endeavoured to induce a stronger polarisation of the nitrogen plate by connecting it with *three hydrogen plates* immersed in the same liquid, as shown in Fig. 4. The acid employed was hydrochloric of sp. gr. 1·100.

In my first experiments with this four-tubed cell, all the three hydrogen tubes being connected by means of thick copper wire with the nitrogen tube, I was surprised to find that, whilst two of the hydrogens contracted equally, the third underwent a much smaller contraction; and, on repeating the experiment, this same tube showed a still more marked difference in the contraction undergone by its contents. I traced the cause of this to faulty contact between the copper wire and the platinum wire passing through this particular tube, for, on pushing the ivory cup at the top of this wire further on, so that the wire projected further into the cup and better contact was effected between it and the copper wire in several subsequent experiments, the contraction in *all three* hydrogen tubes was

FIG. 4.



exactly equal. This is an additional proof of the essentially electro-chemical character of the contraction observed.

The contraction of the hydrogens and the nitrogen gas in this apparatus usually continued equally in all four tubes for about three hours, after which the hydrogens all contracted together, whilst the nitrogen retained a constant volume, and subsequently began to expand. The

expansion of the nitrogen usually amounted to about one-third of the total contraction of the hydrogens.

When two cells, each containing four tubes, were connected together, the three hydrogens of the one with the one nitrogen of the other reciprocally, the gas in all the eight tubes contracted very slowly but equally to the amount of about 1-3rd of an inch. After thirty-six hours, no expansion had occurred in the nitrogen tubes, but twelve hours later the nitrogen in each cell had *expanded* ½ inch, whilst the six hydrogens had each undergone a further *contraction* to an equal amount.

Evidence of the Formation of Ammonia by Combination of Nitrogen and Hydrogen in Grove's Gas Battery.

Special care having been taken to employ hydrochloric acid free from ammonia, and to avoid access of ammonia gas during the experiment, the following results are considered satisfactory.

20 c.c. of hydrogen gas having disappeared in the four-tubed cell above described, the acid in the cell, which was hydrochloric, of sp. gr 1·100, was mixed with a solution of platinic chloride, and the resulting liquid evaporated down to a small bulk. 0·08 grm. of ammonio-platinic chloride was obtained, yielding the theoretical weight of platinum on ignition. Now, if 2-3rds of the hydrogen (20 c.c.) had combined with nitrogen, a quantity of ammonio-platinic chloride would have resulted, weighing 0·084 grm. It seems, therefore, that a portion of the hydrogen eliminated from the N plate, combines with nitrogen to form ammonia, whilst the remainder accumulates as free hydrogen in the nitrogen gas.

As long as the nitrogen retains a constant volume, the change is probably represented by the equation—

$$N + H_4 = NH_3 + H.$$

But the accumulation of free hydrogen in the N tube gradually brings the two platinum plates into a similar electrical condition, hence the gradual diminution in the force of the electric current, and also in the amount of chemical combination occurring between the gases in the nitrogen tube.

Experiments with Air and Hydrogen in Grove's Gas Battery.

Having proved that nitrogen and hydrogen do combine, at all events partially, in Grove's gas battery, I determined to try a few experiments with air and hydrogen placed in the same conditions. My anticipation was that the oxygen would first combine, and that contraction would take place in the proportion 1 to 2, till all the oxygen of the air had disappeared. The result proved different. The contraction invariably took place at first in the proportions 5 of air to 14 of hydrogen. This continued until about one-fifth of the volume of the air had disappeared, after which the air began to expand, whilst the hydrogen still continued to contract.

When air and hydrogen were confined over H_2SO_4 (sp. gr. 1·220), the first deflection of the needle amounted to 6° from H to air. Permanent deflection 2° from H to air.

Oxygen and hydrogen in the same cell, over the same acid, gave a deflection at first of 25°, whilst the permanent deflection amounted to 4°.

Ammonia was found in the acid over which air and hydrogen had been contracting.

Experiments in which the Platinum Plates in Grove's Gas Battery were in similar Conditions, but in which the Results were Modified by the Action of the Effluve upon the Gases.

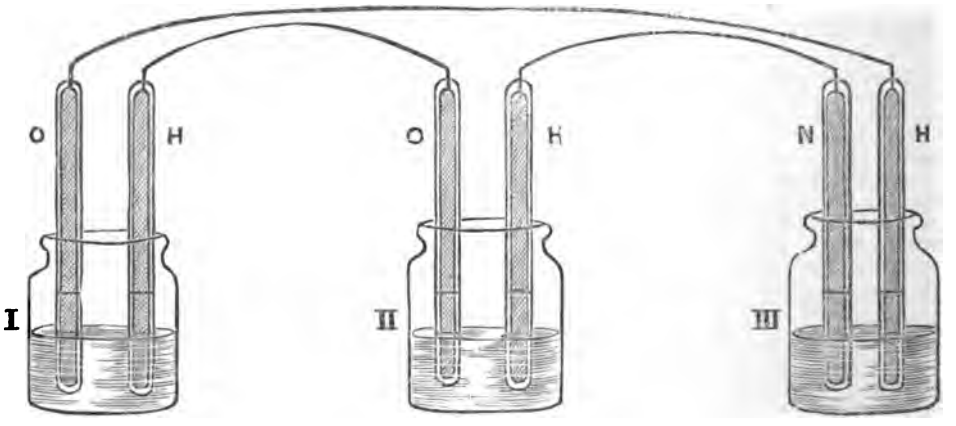
Besides the apparatus previously described, a specially devised cell was employed in the experiments, composed entirely of glass and platinum (see Fig. 5).

The experiments were conducted with pure H_2SO_4 in the cell, since it is essential, as before explained, that the nitrogen be perfectly *dry*, in order that it may be rendered active by the effluve.

It was first ascertained by careful experiment that the passage of the effluve round one of the tubes when both were filled with acid completely, did not produce the slightest disturbance of electrical equilibrium in the platinum plates, or at all events none that could be detected by the galvanometer which I made use of.

When pure *nitrogen* was introduced into both tubes, no current was observed. When one tube was left full of H_2SO_4, and pure nitrogen was introduced into the other, a very feeble current at first set in towards the plate immersed in the acid from that surrounded by gas, deflecting the needle through 1°. By means of a piece of tin-foil wrapped round the exterior of the tube containing the nitrogen, the effluve was made to act upon the gas, one wire from the induction coil being connected with this tin-foil, and the other with the platinum plate in the interior through its wire. After passing the effluve for five hours consecutively through the nitrogen on four different occasions, and subsequently making contact with the galvanometer, currents were observed varying in intensity from 10° to 22°, but in all cases proceeding *from* the plate which was immersed *in the acid towards* that surrounded by the nitrogen gas. Thus the effect of the effluve upon the nitrogen was evidenced not only by an increased intensity in the current produced after electrisation, but also by a complete change in the *direction* of the current.

FIG. 5.



H_2SO_4. Sp. gr. 1·22. H_2SO_4. Sp. gr. 1·22. HCl. Sp. gr. 1·10.

When nitrogen and hydrogen gases were introduced into a cell containing oil of vitriol, one of the platinum plates of which was somewhat more thickly platinised than the other, the nitrogen being in the more thickly platinised plate, and the two plates connected by a short thick copper wire; contraction took place in the proportion of 1 vol. of N to 3 vols. of H exactly, and continued for more than a week in the same proportions after the effluve had been passed through the nitrogen for about ten hours. Total contraction of nitrogen about 1 inch in a ¼ inch tube. At the end of the week the nitrogen began to expand, but again contracted on applying the effluve to it for six hours continuously and then connecting again with the hydrogenised plate. Thus by electrising the nitrogen, that gas may be made to combine completely with the hydrogen generated from the portion of its plate immersed in the acid.

I was unable by means of the small coil in my possession to produce any current perceptible by my galvanometer by electrising one of two nitrogen tubes in Grove's gas battery. Being, however, convinced that with electricity of higher tension, I should find it practicable to demonstrate this disturbance of equilibrium between two platinum plates, one surrounded by ordinary, the other by electrised nitrogen, I tried some experiments, with the kind help of Mr. W. Spottiswoode, with a very powerful induction coil fed by a dynamo-machine. I was enabled by means of the powerful current thus produced to observe very decided, though temporary, currents from the electrised nitrogen plate towards the other, but as I did not employ the same galvanometer, I cannot give comparative measurements of the intensity of the currents produced.

When nitrogen and hydrogen gases over H_2SO_4 were confined in the glass cell figured last, and the effluve from Mr. Spottiswoode's large coil was passed through the *nitrogen*, the following results were observed:—

1. Effluve passed through nitrogen for one hour and a half:—

Contraction of hydrogen = 3¼ inches.
„ „ nitrogen = ¼ inch.

2. Effluve through nitrogen for one hour and a half, the nitrogen having expanded again to its original volume during the week's interval which elapsed between the two experiments, whilst the hydrogen had not altered in volume:—

Contraction of H = o.
„ „ N = ⅛th inch.

3. Effluve through N for one hour:—

Contraction of H = o.
„ „ N = ⅛th inch.

4. Effluve through N for three-quarters of an hour:—
H first *expanded* ¼ inch, then contracted ¾ inch.
N contracted ¼th inch.

Effect of the Condition of the Platinum Plates upon observed Phenomena in Grove's Gas Battery. Experiments in which the Two Plates were in Different Conditions as regards the State of their Surfaces.

The first fact established was that when the acid in the cell is as good a conductor of electricity as possible, and the two platinum plates are in directly opposite conditions as regards the smoothness of their surfaces, one being quite polished, whilst the other is thickly coated with electro-deposited platinum (platinised), no current could be perceived by my galvanometer so long as both tubes were full of acid only, and the plates were both devoid of occluded gases. Hence all the indication of electrical disturbance recorded must be attributed to the action of the *gases* employed upon the differently constituted plates and not to the action of the *acid* upon the plates.

When one tube contained a smooth platinum plate, the other a thickly platinised one, the acid in the cell being dilute sulphuric of sp. gr. 1·22, and both tubes being partially charged with pure hydrogen gas, a deflection of 8° was observed on first connecting with the galvanometer, the current proceeding from the platinised plate to the smooth one. Slight contraction was also observed on the part of the gas in the tube containing the platinised plate. On allowing the acid to displace the hydrogen from both tubes, an initial deflection of 12° was observed by a current from the platinised plate to the smooth one. This current gradually diminished, and after twelve hours had completely ceased, no current passing between plates immersed in the acid and devoid of gas.

When a cell containing dilute sulphuric acid (sp. gr. 1·22), and having one plate smooth and the other platinised was charged with pure *nitrogen* in the *platinised* tube and pure hydrogen in the smooth one, a current passed from the *nitrogen plate* to the hydrogen one, deflecting the needle through 6°; and, after standing for one month, the hydrogen was completely unchanged in volume, whilst the nitrogen had undergone only a very slight contraction. On displacing the gases from the two tubes by the acid, a current was observed proceeding from the platinised plate (nitrogen) towards the smooth one (hydrogen), which deflected the needle through 13°.

Same cell; same acid; same plates:—

Pure hydrogen introduced into the tube with the platinised plate and pure nitrogen into that containing the smooth plate. Initial deflection, 12° from H to N. After being connected for three days, the hydrogen had contracted only 2-5ths of an inch, whilst the nitrogen had contracted 1-10th of an inch. No further change of volume occurred after twenty-four hours additional connection. On displacing the gases by the acid, a current of 20° took place from the hydrogenised platinised plate to the smooth nitrogenised one.

These observations seem to me to prove that the action of nitrogen gas upon the platinum plate with which it is in contact, assists the action of hydrogen upon a plate connected with its own plate and immersed in the same acid. In short, the nitrogen appears to exist in the platinised plate in an electro-negative condition, and occasions a *positive* condition of the plate with which it is in contact, whilst the *electro-positive* hydrogen occasions a negative excitement of its adjacent platinum. The two plates being thus in opposite electrical conditions, a current is certain to take place from one to the other.

The occurrence of a current *from* a nitrogenised platinised plate *towards* a smooth hydrogenised one clearly proves that the direction of the current depends mainly upon the relative amount of electrical disturbance of the plates rather than upon the nature of the gas or of the positive or negative disturbance of either plate; and it certainly proves that nitrogen gas as it exists in contact with platinised platinum is not a purely inactive element.

In fact, however imperfect these researches may be, they seem to me to lend valuable additional evidence of the existence of an allotropic, active, and, I think I may now add, electro-negative form of *nitrogen*.

The description of the various experiments I have made with Grove's gas battery being somewhat detailed, it may be well to summarise briefly the results obtained and the inferences drawn therefrom:—

1. Nitrogen and hydrogen gases are capable of generating powerful currents in Grove's gas battery.
2. These currents are inversely proportional to the resistance offered by the acid in the cell.
3. The hydrogen always contracts in volume. If the resistance be great in the connecting wire between the two plates, whilst that in the acid is small, the nitrogen *expands* as much as the hydrogen contracts, no combination taking place between the gases.
4. When the resistance, both through the connecting wire and also through the acid, is reduced to a minimum, the nitrogen at first retains a constant volume, only expanding after a lapse of some hours,

and the total contraction of the hydrogen is often three times as great as the expansion of the nitrogen, a considerable proportion of the gases combining to form ammonia.

5. Complete combination of nitrogen and hydrogen gases to form ammonia, with contraction of both gases, in proportions N_1 to H_3, may be effected by subjecting the nitrogen to the action of the effluve whilst it is in contact with a platinised platinum plate.
6. The contact of nitrogen with a platinum plate certainly produces a disturbance of the electrical equilibrium of the platinum, for a current may be demonstrated passing from a platinised platinum plate surrounded by nitrogen gas towards a smooth platinum plate immersed in pure hydrogen gas.
7. Nitrogen, in contact with a platinum plate, shows signs of electro-negativity in Grove's gas battery, which are intensified by the action of the effluve upon the gas, and hence the duality of nitrogen receives support from the phenomena described above.

King's College, London, 1883.

NOTICES OF BOOKS.

Energy in Nature, being, with some Additions, the Substance of a Course of Six Lectures upon the Forces of Nature and their Mutual Relations, delivered under the Auspices of the Gilchrist Educational Trust in the Autumn of 1881. By W. Lant Carpenter, B.A., B.Sc, Fellow of the Chemical and Physical Societies, and of the Society of Chemical Industry. Cassell and Co., Limited: London, Paris, and New York.

The work before us may be approximately considered as a popularised edition of the well-known *Correlation of Physical Forces*, with such additions and emendations, both in point of fact and theory, as the present state of knowledge demands. The author endeavours to explain at the outset the distinction between *force* and *energy*, still often confounded together, and to explain how and why "the language of the older books on the so-called Forces of Nature, the Correlation of Forces, &c., has been of late modified by the development of the doctrine of Energy and its Conservation." Says he: "The book may be shortly described as an endeavour to expound in popular, and yet accurate language, the meaning and consequences of that important principle known as the Conservation of Energy." This undertaking cannot be considered as other than highly laudable, since, without a clear underlying comprehension of this principle, scientific research and even scientific study will be, in most departments devoid of any sound and rational foundation. Mr. Carpenter may further be congratulated on the manner in which he has fulfilled his task. His book is the more opportune because a heresy has lately sprung up under the name of Substantialism, which, if we do not misunderstand its advocates, looks upon light, heat, and even sound, not as modes of motion, but as substantive entities. This doctrine is being zealously preached in America, chiefly by theologians, lawyers, military men, &c., who having the advantage of not understanding what they talk about can adduce arguments difficult to meet because beside the question.

In his successive chapters, or rather lectures, for such they originally were, the author discusses matter and motion, force and energy; heat as a form of energy, chemical attraction, especially combustion, electricity and chemical action; magnetism and electricity, and energy in organic nature.

The establishment of the doctrine of the Conservation of Energy is ascribed to "Meyer, Helmholtz, Clausius, and others in Germany, and to Grove, Joule, Thomson, Balfour Stewart, Tait, Tyndall, and W. B. Carpenter, in England." The various shares of the work effected by these investigators and of the merit to which they are entitled are left to be ascertained by the reader from other sources.

On the cover of the book, and again on p. 13, we find a diagram intended to show the correlation of the forms of energy. As some of these forms the author places in a series of circles gravitation, mechanical energy, cohesion, magetism, electrical attraction, moving electricity, radiant energy, heat, light, chemical attraction, vegetable energy, and animal energy. It is nowhere asserted—and the statement if made would be rash—that there may not exist in the universe other forms of energy with whose workings we are not acquainted. All these forms it is contended are capable, directly or indirectly, of mutual interconversion. It will also be understood that by vegetable and animal energy the author cannot mean life, since he says: "We do not exactly know what energy is, but we recognise it just as we recognise life in various forms." Here life is clearly distinguished from the forms of energy which nevertheless accompany it.

The subject of electricity and its relation to chemical attraction and to magnetism are discussed at a relatively great length and in an interesting manner. In the description of the telephone, however, its inventor, Reiss, is left out of sight.

The sixth chapter, which treats on energy in organic nature, contains some passages worth special notice. We read:—"It is a well-known fact that when people die of starvation the cause of death is really *cold*, *i.e.*, inability to maintain the heat necessary for the vital processes; hence when food is scarce much less is needed if the body be kept warm; a fact noted by a careful Lancashire housewife, who during the last cotton famine kept the men of her household in bed and well covered up, for about twenty hours out of the twenty-four." It is not generally known that the phrase "to be starved," which in London and the South of England refers to the want of food, is in the North understood to mean suffering from cold.

It is a question whether in this book, as in many others, too much stress is not laid on the so-called "balance of organic nature." We do not know whether the vegetable creation exactly decomposes the supply of carbonic acid evolved by the respiration of animals and other sources, and consequently whether the relative proportions of that gas and of oxygen in the atmosphere are fixed or fluctuating. Still less do we know whether the totality of fixed or combined nitrogen in the earth, the waters, and the atmosphere is constant. That it undergoes constant waste by conversion into free nitrogen *e.g.* on the decomposition of animal and fœcal matters, is established beyond doubt. But so far all attempts to detect an adequate recuperative process, whether of organic or inorganic nature, have given merely negative results. Hence it is with the greater surprise that we find Mr. Carpenter quoting in a note as "very suggestive in this connection," *i.e.*, in reference to the balance of organic, an extract from a work entitled "Progress and Poverty," by Mr. Henry George. This author says: "That the earth could maintain a thousand billions of people as easily as a thousand millions is a necessary deduction from the manifest truth that, at least as far as our agency is concerned, matter is eternal and force must for ever continue to act."

To us it appears that the indestructibility of matter and the persistence of energy have no connection whatever with the population our earth is capable of supporting. Since a parcel of matter cannot be in two places at the same time the possible population of the earth is limited by the quantities of certain elements existing in certain states of combination which are manifestly not eternal. Let us suppose a small planet containing in its soils, waters, and atmosphere 1000 grms. of combined nitrogen. Suppose it inhabited by a race of beings each of which, on an average, required to contain in its body 1 grm. of combined nitrogen. It is therefore manifest that not more

than 1000 such beings could exist upon that planet at any given time. In reality the number would be much less, since a large share of the combined nitrogen would be locked up, temporarily in the plants used for food, and in the excreta of the inhabitants, and a portion wasted and as good as destroyed by reversion to the state of free nitrogen.

Our earth repeats the same state of the case on a larger scale.

It is to be regretted that such wild speculations should be reproduced in a work of such merit as the one before us.

Mr. Carpenter sums up the teachings of his book in the following set of propositions:—"That where one (of the forms of energy) is excited or exists, many others are also set in action; hence probably all are modes of motion; that any one may be transformed, either directly or by intermediate steps, into any other; that none of them can be produced but by some other as an anterior, and that they act uniformly, *i.e.*, according to fixed laws."

Annual Report of the Chemical Examiner's Department for 1882-83. (Bengal Medical and Municipal Department). Calcutta, 1883.

That "India is the only British colony in which there is no Pharmacy Act or law to regulate the sale of poisons," as this report tells us, may in some degree account for the very large number of cases of suspected poisoning that annually come under the chemical examiners' notice and which are recorded in this report. During the past year there were altogether 210 cases of human viscera examined (population not stated), poison being detected in 98 instances or 46·6 per cent of the number examined. Of the poisonous agents detected opium, arsenic, and aconite, take the first rank, and indeed almost make up the total number, with percentages of 26·6, 12·3, and 2·38 respectively. "These figures, though showing a slight improvement on the results of the previous year, and a greater improvement on the average of the five years ending 1879-80, are still far from being satisfactory."

The difficulties that the chemical examiner has to contend with as regards the way in which matters of such importance as the packing and rapid despatch to his laboratory of viscera, in cases of suspected poisoning, are certainly ludicrous, and seem to indicate a degree of laxity and carelessness on the part of the officers equal to that of the law-makers, who have as yet neglected the passing of a Pharmacy Act. We are told that "To many officers a daub of sealing-wax, or shell-lac, or a smudge with ink, in which no distinct impression is visible, does duty for a seal, and there can be no doubt that the object with which seals are directed to be affixed to parcels, &c., is not universally grasped." Advising the despatch of a stomach for analysis, the following is an example of the style of letter:—"I have despatched by a banghy parcel the stomach of Khaibe Byastabi for favour of your reporting result of the analysis. 'The opinion of the Hospital assistant of this sub-division is that death of the said woman is caused from the effects of some irritant poison.' No *post-mortem* report, no description of the mode of packing or copies of label attached to bottle." In another case liver, spleen, and intestines were sent, but no *stomach*, with the following report:—"I am of opinion that the man has died, seeing his internal organs congested!" Again—"My opinion that death may have resulted from poisoning, but I am not confident to say so: therefore, stomach needs be sent to the chemical examiner. As far as I think, it was an irritant, inorganic poison, perhaps foreign to me." This stomach was sent, but the contents had been thrown away by the native doctor! Evidently, in this latter case, the native doctor was partly in fault, but who, we should like to know, were responsible for the above very learned opinions. Were they English "trained" medical men in private practice, or those who have passed their examinations "with honours" into the Government service? If native doctors, then they may reasonably be excused.

The subject of potable waters, a matter truly of the highest importance in such a climate as India, is considered at some length, and the great number of analyses that are embodied in the report are of value from a sanitary point of view. Appended to this report Dr. Warden gives the results of some interesting experiments he made on "Sui" poisoning, *i.e.*, poisoning by *Koonch* or *Goontch* seeds pounded and shaped into needles, which are employed by the natives for poisoning animals by forcing the needle through the skin of the victim. The original article on this subject is to be found in the *Indian Medical Gazette*.

Arithmetical Chemistry or Arithmetical Exercises for Chemical Students. By C. J. Woodward, B Sc. Principal Chemistry and Physics Department, Birmingham and Midland Institute. Part II. London: Simpkin, Marshall, and Co., Birmingham: Cornish Brothers.

This work is a very favourable specimen of a class which has lately sprung up and which is likely to become more numerous. We fully admit that the student may derive much advantage from the treatment of a number of chemical questions from an arithmetical point of view. But at the same time we must earnestly deprecate the proposal which we have met with elsewhere to make such exercises stand in any way in the place of actual, intelligent, laboratory work. That a thorough mastery of what is taught in the little work before us will be of value to the student engaged in actual research is evident. But after a careful inspection of the exercises here given we fear that it will be of relatively greater utility to those who look upon chemistry, and indeed every other science, as something to be examined and to "pass" in. We find here a list of arithmetical chemical questions set at the University of London in the examinations for the degrees of B.Sc. and D.Sc. from the years 1873 to 1882; similar questions given at the Oxford Local Examinations, 1871 to 1882; arithmetical questions from Cambridge Local Examinations in chemistry, and similiar questions propounded by the sphinx of modern England, the Science and Art Department, in its honours examinations from 1871 to 1883. It will be seen that not a few of these questions are what, in the language of the day, is called "pretty stiff." It will also be recognised that a thorough aquaintance with the teachings of Mr. Woodward's book will do very much towards a solution of these problems. But we cannot shut our eyes to the fact that a mere reader in chemistry—a pen, ink, and paper chemist, who had never performed a single experiment, nor even seen one performed—might be able to answer such questions as well as, possibly better than a skilful and successful investigator of chemical phenomena. It may be a weakness on our part, but we cannot help feeling jealous of anything which may tend to put these two classes upon an equality, or, still more, to favour the reader as against the worker.

Do we, therefore, condemn the book before us and similar publications? Certainly not; they have a legitimate sphere and in that they are useful. But such sphere is of a subordinate, auxiliary character. The danger is that unconscientious teachers, who care merely for what will "tell" at an examination, may be led to place an undue value upon such arithmetical problems and their solution.

A Manual of Chemistry. Vol I. Physical and Inorganic Chemistry. By H. Watts, F.R.S. London: J. and A. Churchill.

The work before us is avowedly based on the "Manual of Chemistry" of the late Professor Fownes, enlarged and modified in accordance with the present state of knowledge. It seems to hold a middle place between the ele-

known "Dictionary of Chemistry." Its object is not to facilitate cram, or to fill the memory with undigested knowledge, but "to prepare the student for the perusal of original memoirs, which, in conjunction with practical instruction in the laboratory, can alone afford a real acquaintance with the spirit of research and the resources of Chemical Science." It is scarcely necessary for us to say that such a purpose has our earnest sympathy.

The work opens with a brief preliminary account of the more important elementary bodies, the laws of chemical combination and the representation of the constitution and the reactions of bodies by symbols and formulæ.

The next section is devoted to chemical physics, a subject now generally omitted in modern treatises on chemistry, in which the student is generally referred to special works on physics, not, perhaps, in all cases with advantage.

The author then proceeds to a review of the non-metallic elements. Immediately after hydrogen he takes up the halogens; then oxygen and its combinations with all the foregoing; sulphur and selenium, followed by tellurium. Arsenic also is classed as a non-metal, being made to succeed its near allies nitrogen and phosphorus.

After the non-metallic bodies have thus been systematically described the atomic theory is discussed with great fulness and clearness. Under "structural formulæ" we find the often repeated, but perhaps still more often forgotten, caution, that these formulæ "are not intended to represent the actual arrangement of the atoms in a compound; indeed, even if we had a distinct notion of the manner in which the atoms of any compound are arranged, it could not be adequately represented on a plane surface."

The part played by Mr. Newlands in the discovery of what is now known as the "periodic law" finds here due recognition. The nature of dissociation—sometimes misunderstood as a mere synonym for decomposition—is explained. So also are the foundations of thermo-chemistry.

The next portion of the work is devoted to the metals, the rarer and more recently discovered ones being here duly included.

Lastly follow tables of thermometric and hydrometric scales, and of the metrical system of weights and measures. The work may be characterised as containing a surprising quantity of correct information, clearly expressed and conveniently arranged. The index is very full, and, as far as we have been able to test it, accurate.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 16, No. 5.

Condensation-Products of Acetacetic Ether.—A. Hantzsch.—Among the products obtained are mesityl-oxide dicarbonic ether, mesityl oxide anhydro-dicarbonic ether, and a crystalline body, the constitution of which is still doubtful.

Normal Primary Hexylic Alcohol and its Derivatives.—J. Frentzel.—The author has studied formic hexyl-ether, sodium hexyl-alcoholate, benzoic hexyl-ether, hexyl-chloride, and mono-hexyl-sulphurea.

Certain New Glyoxalines.—Br. Radziszewski.—An examination of glyoxal iso-butyline, glyoxal-iso-amyline, and glyoxal-iso-œnanthyline.

Silver Hypophosphite.—Jul. Philipp.—Phosphorus, heated with dilute nitric acid in presence of silver nitrate, crystallises out, unless too much nitric acid is present.

Basic Glucinum Potassium Oxalate.—Jul. Philipp.—This salt is characteristic on account of its remarkable tendency to crystallise, and is therefore very serviceable for obtaining the glucinum compounds in a state of purity

Glycocoll.—Theodor Curtius.—The author has studied the ethyl-ether of glycocoll and the substituted glycocolls.

The Connexion of the Combustion-heat of Isomeric Organic Compounds with their Density—Müller Erzbach.—The differences in combustion-heat increase with the difference in density. This relation of organic compounds affords a new confirmation of the proposition deduced by the author from the volume relations of the most various classes of inorganic bodies that the transformations occasioned by chemical affinity press the active masses more and more together with a constant increase of the mean density, according to the principle of the least space.

Determination of the Influence of the Temperature and Concentration of Hydrochloric Acid upon the Rate of Inversion of Saccharose.—Fr. Urech.—Not susceptible of useful abstraction.

Formation of Nitrile Bases from Organic Acids and Amines.—Aug. Bernthsen.—The author argues that a base described, *Berichte*, xv., 3011, is formed by the direct action of benzoic acid and diphenylamine.

Nitroso-oxindol and Nitroso-indoxyl.—A. Baeyer.—Referring to a paper by Gabriel (*Berichte*, xvi., 518), the author states that he had made the same observations some time previously, and in concert with Comstock and Sapper and with Victor Meyer has begun an investigation on the constitution of nitroso-oxindol and nitroso-indoxyl.

Journal de Pharmacie et de Chemie.
Tome viii., November, 1883.

Observations on the Sanitary and Therapeutic Use of Copper Sulphate.—A. Riche.—The fact that bacteria and their germs cannot survive in contact with a certain dose of copper sulphate, does not prove that disease germs are unable to enter the organism of a person who has absorbed copper, and, having entered, to survive. The vitality of one and the same microbium varies extremely, according to the medium in which it lives. A microbium killed in a given solution by a certain dose of an antiseptic might resist the same dose if in the blood.

Certain Anhydrides and Mixed Anhydrides of Acetic Acid, and on Chlorinised Acetic Acids.—H. Anthoine.—The author describes dichloracetic anhydride, trichloracetic anhydride, a mixed acetic monochloracetic anhydride, a mixed acetic dichloracetic anhydride, and a mixed acetic trichloracetic anhydride.

Preliminary Non-decomposition of Saccharose and Maltose in their Lactic Fermentation.—E. Bourquelot.—This paper does not admit of useful abridgment.

Waters of the South Oranais.—M. Baillon.—In Algeria there does not exist a definite relation between the flora and the fauna of waters and their sanitary value. Thus watercress, veronica, as well as the Physali and Lymnæi, which, according to certain authorities, are found in France only in good potable waters, have been found by M. Baillon in waters decidedly insalubrious.

Determination of Fatty Acids in Oils.—G. Krechel.—Inserted in full.

Memoir on Flours.—M. Balland.—Already noticed.

Detection of Carbon Disulphide.—M. Vitali.—The author fills a gasometer with pure hydrogen, which he allows to traverse a series of U-tubes, filled with frag-

ments of glass or of pumice steeped in lead nitrate, silver nitrate, and caustic potassa. For the same purpose may be used fragments of pumice steeped in sulphuric acid and in potassium permanganate. The liquid in which carbon disulphide is to be sought is introduced into a three-necked bottle connected to a second bottle containing tartar-emetic. A current of pure hydrogen is made to pass into the former, and then into the latter. The hydrogen is then conducted into a chloride of calcium tube, after which it may be treated with reagents, or the products of its combustion may be examined In a first trial we receive the gas in a few c.c. of an alcoholic solution of caustic potassa, to whi h are afterwards added a very small quantity of neutral ammonium molybdate and a small excess of dilute sulphuric acid. If the l quid contains traces of carbon disulphide, it takes a rose colour, which then passes to a vinous red. Another portion of the gas is passed into a small volume of an alcoholic solution of lead acetate, to which are added a few drops of caustic potassa, and the mixture is heated to a boil. If the mixture contains carbon disulphide. lead sulphide is produced. If the quantity of carbon disulphide is large it becomes sensible to the smell. The flame has a blue centre, and gives off the odour of burnt sulphur. It decolourises blue starch-paper, blues starch-paper charged with iodic acid. produces a yellow spot upon porcelain, which, if treated with caustic potassa and then with sodium nitro-prusside or lead acetate, gives the reactions characteristic of the presence of sulphur. If a plate of silver is used instead of porcelain there appears a black spot of silver sulphide. If there are dropped upon the porcelain plate, solutions of caustic potassa, of lead acetate, cadmium sulphate, antimony chloride, or arsenious acid, and the flame is allowed to spread over these points of the plate, the characteristic colours of the metallic sulphides appear. If carbon disulphide is mixed in more or less considerable quantities with solid matters, they are divided as finely as poss ble, distilled along with water acidulated with sulphuric acid, and the distillate is further examined as above. If it is required to detect carbon disulphide in lighting-gas, the gasometer is filled with this gas, and the process is conducted as described.

MISCELLANEOUS.

The Liebig Memorial.—The *Chemiker Zeitung* reports that the statue of Liebig which was unveiled in August last has been wantonly, and it is feared permanently, injured. A black liquid, which appears to penetrate into the marble, has been thrown upon the head and left shoulder of the figure, and has run down to the pedestal.

Madrid Exhibition.—The well-known firm of Robert Daglish and Co., St. Helen's Foundry, Lancashire, have been awarded "Honourable Mention" for pho ographs of their Gold Reduction Machinery. This is certainly satisfactory for mere drawings; had the machinery itself been exhibited it would have had a gold medal awarded.

MEETINGS FOR THE WEEK

MONDAY, Dec. 10th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.
TUESDAY, 11th.—Institute of Civil Engineers, 8.
—— Photographic, 8.
—— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 12th.—Society o Arts, 8. "The Preparation and Use of Rhea Fibre," by J. Forbes Watson, M.A., M.D.
—— Microscopical, 8.
THURSDAY, 13th.—Royal, 4 30.
—— Philosophical Club, 6.30.
FRIDAY, 14th.—Astronomical, 8.
—— Quekett, 8.

TO CORRESPONDENTS.

G. T. D.—Most ammonium salts dissociate more or less when sublimed. Ammonium sulphate partially splits up in this way, but you cannot practically drive off the ammonia by heat from it.

THE PATENTS
DESIGNS AND TRADE MARKS ACT
1883.

WITH INTRODUCTION, NOTES, AND INDEX TO THE SECTIONS RELATING TO PATENTS.

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The Directors of the DEVON FRIENDSHIP MINING COMPANY (Limited) are prepared to receive TENDERS on or before the 11th December prox., for their PRODUCTION of CRUDE ARSENIC for the year 1884.
The Arsenic to be sold by ton of 21 cwts., of the company's usual make, delivered free on rail at Mary Tavy station, Devon. Casks to be returned at buyer's expense to Mary Tavy station. Payment by net cash on delivery.
The Directors do not bind themselves to accept the highest or any Tender.
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8, Austin Friars, London,
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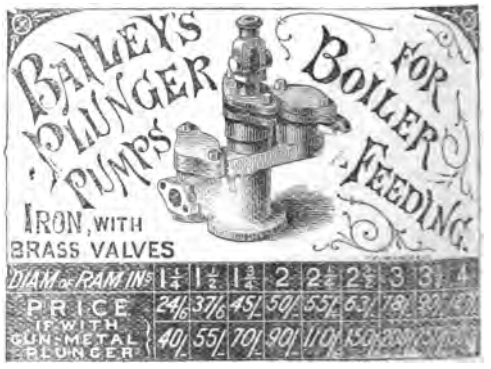

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THE CHEMICAL NEWS.

Vol. XLVIII. No. 1255.

THE VOLUMETRIC DETERMINATION OF MANGANESE.

By GEORGE C. STONE.

In a paper* read before the American Institute of Mining Engineers at the Roanoke meeting, Mr. J. B. Mackintosh criticised some conclusions that I had stated in a paper† on the same subject read before the Institute at the previous meeting.

My original statement was :—

"Needing a rapid and tolerably accurate method for determining manganese in spiegel, I tried Williams's‡ method as promising better than any that I knew of. On making comparison analyses by it and the acetate and phosphate method, I found that it gave me only about ninety per cent of the manganese, the difference being always proportional to the amount of manganese. The method is based on the supposition that manganese is precipitated by potassium chlorate from a nitric acid solution entirely as MnO_2. It occurred to me that this might not be correct; on trying it I found it was not. To test it I precipitated 0·5 gr. of a spiegel, in which I had previously determined the manganese by Ford's‖ method, by potassic chlorate, and added the precipitate to a fresh solution of iron wire, made as is usual for standardising permanganate, and, after dissolving, determined the excess of unoxidised iron by permanganate which had just been standardised by the same iron wire dissolved in the same manner. The results were as follows :—

	I.	II.
Manganese found by Ford's method ..	0·0675	0·0679
Iron that would be oxidised if the precipitate were MnO_2	0·1374	0·1382
Iron actually oxidised	0·1117	0·1119

This result would give very nearly the formula $10MnO_2,MnO$. I then tried standardising the oxalic acid solution by a spiegel which had been repeatedly analysed by different chemists and obtained excellent results.

The method of analysis finally adopted is as follows :—Dissolve 0·5 gr. of spiegel in 40 c.c. nitric acid (1·42 sp. gr.) by boiling, add gradually an excess of potassic chlorate, cool, filter through asbestos (using a filter-pump), and wash three or four times with water. The precipitate will still contain some iron, but it does not interfere. Add the precipitate and asbestos to an excess of standard oxalic acid (8 to 8·5 grms. to one litre), add sulphuric acid, and heat till dissolved, titrate the excess of oxalic acid by permanganate (about 3 grms. to the litre)."

It will be seen from this that the method as I use it does not depend on the composition of the precipitate; but merely on its being of a definite and constant composition. It must be remembered that my conclusions as to the composition of the precipitate referred only to spiegel. Mr. Mackintosh reduced a measured volume of permanganate solution, precipitated with potassic chlorate, and determined the oxidising power of the precipitate by means of the same oxalic acid he had previously used for standardising his permanganate, and found the precipitate was MnO_2. He entirely ignores the probable influence of the large amount of hydrocarbons present derived from the combined carbon of the spiegel and also the possible influence of the large excess of iron. Further he neglected to directly determine the manganese present in his permanganate, but assumed that it was all present as $KMnO_4$, whereas, especially if the solution has been standing some time, it is apt to contain lower oxides.

To test the effect of different conditions I have tried reducing permanganate* by hydrochloric acid, evaporating to dryness, adding 0·5 grm. spiegel (the value of which in oxalic acid had been previously determined), dissolving the whole in nitric acid, precipitating by potassic chlorate filtering, and determining the oxidising power of the precipitate with the results shown in Table (see next page).

To further test the methods I have analysed a sample of spiegel by the methods in question (Williams's† method and the modification of it I proposed), and repeated the analysis, adding 0·2 grm. pure $Mn_2P_2O_7$ to each lot before dissolving, with these results :—

Spiegel used.	Manganese added.	Manganese found by Williams's method.	Gain.	Manganese found by modified method.	Gain.
Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
0·5	—	0·10273	—	0·11037	—
0·5	—	0·10273	—	0·11037	—
0·5	0·07746	0·17434	0·07142	0·18749	0·07712
0·5	0·07746	0·17327	0·07054	0·18634	0·07597

The $Mn_2P_2O_7$ used I prepared from ferro-manganese with great care as follows:—I dissolved the ferro-manganese in nitric and sulphuric acids and evaporated till copious fumes of SO_3 were given off, diluted, and precipitated the iron as basic acetate as usual. I did not wash at all, but used only the filtrate, evaporated to dryness, took up with water and a few drops of acetic acid, boiled, and filtered from the small precipitate of iron that separated. I tested this filtrate for iron with ferrocyanide, but obtained no reaction. I then precipitated the manganese by bromine, filtered, and washed very thoroughly, dissolved in hydrochloric acid and precipitated as phosphate; filtered, washed, dissolved in hydrochloric acid, re-precipitated by ammonia and a little sodic phosphate; filtered, washed with the pump, dried, brushed from the paper, and ignited to pyrophosphate.

In reference to the manner of precipitating by potassic chlorate Mr. Mackintosh says:—"The manganese was precipitated by potassic chlorate; and, after standing some time to cool—*a precaution which we consider of importance*—the precipitate was filtered." (The italics are mine.) He, however, gives no reasons for considering it of importance to cool before filtering. As I usually filter hot, I thought it better to try whether it did make any difference; so tried it as follows :—

Sample No.	Filtered hot, found.	Filtered cold.
67	20·67 per cent	20·85 per cent.
313	11·81 ,, ,,	11·69 ,, ,,

In one case the solution filtered hot gave the higher result, in the other the one filtered cold; in neither case was the difference greater than would be allowable in duplicate analyses. He also says :—"Shortly after first employing the method we (Mackintosh, Beele, and Colby) noticed that the reaction was seldom complete when potassic chlorate was added during one period only. On this account it is necessary, in employing this method, to add alternate amounts of potassic chlorate and nitric acid, until no further effect is produced; and if this precaution is neglected, the results will almost invariably be low." As this is evidently meant to explain why I got low results when I first tried the method I would say that I have always added the potassic chlorate in successive portions until no further reaction was produced. I think the following analyses will show whether the different methods of

* Chemical News, vol. xlviii., 1246, p. 176.
† *Trans. Am. Inst. Min. Eng.*, vol. xi.
‡ *Ibid.*, vol. x., p. 100.
‖ *Ibid.*, vol. ix, p. 397.

* I determined the Mn in the permanganate used and found it to agree very closely with the amount calculated from the oxidising power.
† *Trans. Am. Inst. Min. Eng.*, vol. x., p. 100.

Grm.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.
0·5	—	24·49	—	—	—	—	—	—
0·5	—	24·49	—	—	—	—	—	—
0·5	45	40·60	24·49	16·11	18	89·50	16·36	98·47
0·5	35	36·98	24·49	12·49	14	89·21	12·72	98·19
0·5	25	33·58	24·49	9·09	10	90·90	9·09	100·00
					Average per cent	89·87		98·89

working produce any appreciable effect; they were made on the same samples with oxalic acid standardised in the same manner:—

Sample 4.		Sample 76.	
Beele ..	13·85 per ct.	Mackintosh	12·20 per ct.
,, ..	13·98 ,,	,,	12·44 ,,
Stone ..	13·81 ,,	,,	12·92 ,,
,, ..	13·88 ,,	,,	13·03 ,,
		Sands	12·31 ,,
		,,	12·45 ,,

The two first analyses of 76 were Mr. Mackintosh's original determinations, the next two were "repeated with great care." Mr. Sands was formerly my assistant. He made the analyses in my laboratory when we were first investigating the method.

I think the experiments here given are sufficient to explain the difference in the results obtained by Mr. Mackintosh and myself, and to confirm my original conclusions.

N. J. Zinc and Iron Company,
Newark, N. J., Nov., 1883.

THE PURIFICATION OF AMMONIUM FLUORIDE.

By PETER T. AUSTEN and FRANCIS A. WILBER.

One of the most convenient methods of determining silica in titaniferous and other ores is to expel it as fluoride by means of ammonium fluoride and sulphuric acid, or by fluorhydric acid alone. But the practical difficulty here met is the impossibility of getting either ammonium fluoride or fluorhydric acid in a pure state, for it is of course absolutely necessary that they should leave no residue after volatilisation. The following procedure has enabled us to use the articles obtainable in commerce with excellent results.

The amount of ammonium fluoride necessary for the analysis is dissolved in as little water as possible in a platinum dish, and strong ammonia added in slight excess. If fluorhydric acid is used the ammonia is added in small amounts from a pipette, so as to avoid spitting. In this case the operation is of course performed under a good hood. In both cases a voluminous precipitate will be obtained. A five-inch filter-paper, which has previously been extracted* with fluorhydric acid to remove silica, is folded to the sixteenth fold, making a cone of an angle of about 67°. If the papers are very thin it is well to take two of them and fold them together. This cone is then placed in a ring of stout platinum wire, which may be conveniently held in the ring of a ring-stand by three smaller platinum wires. The liquid is decanted into this filter and allowed to filter at once into the platinum crucible containing the ore. The crucible is then placed on a water-bath and the liquid concentrated. This step is not necessary unless the bulk of the liquid is large or the crucible small, and indeed had better be avoided, since ammonium fluoride is quite volatile. The liquid is next made acid with sulphuric acid, evaporated to dryness and ignited as usual. Should it be feared that the silica had not been entirely expelled, the operation should be repeated; but it will be found that as a rule one treatment is sufficient. The ammonium fluoride prepared in this way we find does not leave any appreciable residue. Of course every new lot or ammonium fluoride or fluorhydric acid, before being used in analysis, should be tested for residue after treatment in this manner.

We prefer to use the acid in analysis, purifying it and converting it into the ammonium salt by the above method, for its cost is but one-third of that of the ammonium fluoride and it affords a more concentrated solution.—*Amer. Chem. Journ.*

* Papers freed from ash by treatment with chlorhydric and fluorhydric acids are now manufactured by Schleicher and Schull by a method described by me in 1878 (Chemical News, 37, 149) and tested and approved by Profs. Fresenius and Caspari (*Zeitschrift für analytische Chemie*, 22, 241).—P. T. A.

THE VOLUMETRIC DETERMINATION OF COMBINED NITROUS ACID.

By LEONARD P. KINNICUTT and JOHN U. NEF.

The amount of nitrous acid contained in commercial samples of potassic and sodic nitrites has been commonly determined in the following manner. The nitrites are dissolved in slightly acidulated water; a solution of potassic permanganate is added till the oxidation of the nitrous acid is nearly completed; the solution is then made strongly acid, and potassic permanganate added until the solution has a faint red colour.

This method is far from satisfactory, closely agreeing results being rather the exception than the rule. The cause is most probably due to the escape of a small amount of nitrous acid, and also to the slow oxidation of the last traces of the nitrous acid by the potassic permanganate.

A further study of the analyses of nitrites volumetrically seemed desirable, and after numerous experiments the following process, or modification of the old process, as it might more properly be called, was devised.

The sample of nitrite is dissolved in cold water, one part of the salt to at least three hundred parts of water. To this solution a decinormal solution of potassic permanganate is added, drop by drop, till the liquid has a decided and permanent red colour, then two or three drops of dilute sulphuric acid, and immediately afterwards an excess of the potassic permanganate solution. The liquid, which should now be of a dark red colour, is made strongly acid with sulphuric acid, heated to boiling, and the excess of potassic permanganate determined by means of a decinormal solution of oxalic acid.

Analyses of samples of both potassic and sodic nitrites, made in accordance with the above modification, show that results agreeing very closely with one another can easily be obtained.

Potassic Nitrite Solution.
(One litre contained 4·3550 grms.).

Taken.	KNO_2 found.
25 c.c. = 0·1089 grm.	0·09194 grm. = 84·44 per cent.
35 c.c. = 0·1525 ,,	0·1289 ,, = 84·48 ,,
40 c.c. = 0·1742 ,,	0·1472 ,, = 84·51 ,,
55 c.c. = 0·2395 ,,	0·2024 ,, = 84·49 ,,
60 c.c. = 0·2613 ,,	0·2210 ,, = 84·53 ,,

Sodic Nitrite Solution.

(One litre contained 3·090 grms.).

Taken.	$NaNO_2$ found.
25 c.c. = 0·0919 grm.	0·07713 grm. = 83·95 per cent.
35 c.c. = 0·1287 ,,	0·1082 ,, = 84·07 ,,
45 c.c. = 0·1654 ,,	0·1390 ,, = 84·05 ,,
53 c.c. = 0·1949 ,,	0·1639 ,, = 84·03 ,,
60 c.c. = 0·2206 ,,	0·1854 ,, = 84·05 ,,

The volumetric method for the determination of sulphites is also most unsatisfactory. The study of this subject was therefore given to Mr. R. Penrose, a student in this laboratory. He experimented both with potassic permanganate and oxalic acid as above, and also with iron alum and the permanganate; but although many variations of these processes were tried, and the work carefully conducted, the results were not satisfactory.—*Amer. Chem. Journ.*

ALUMINIUM SULPHATE.

By SPENCER U. PICKERING, M.A. (Oxon.)

In the *Comptes Rendus*, xcvi., 844, I see that P. Marguerite-Delacharlonny states that pure aluminium sulphate crystallises with 16 molecules of water, and not with 18, as is usually asserted. On referring to some notes of 1881, I find that I obtained results confirmatory of this statement, aluminium sulphate, on re-crystallisation and drying between blotting-paper, having been found to yield analytical numbers agreeing closely with the formula—

$$Al_2(SO_4)_3,16H_2O.$$

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B., Chief Chemist to the U.S. Geological Survey, Washington.

THALLIUM.

THE atomic weight of this interesting metal has been fixed by the researches of Lamy, Werther, Hebberling, and Crookes. Lamy and Hebberling investigated the chloride and sulphate; Werther studied the iodide; Crookes's experiments involved the synthesis of the nitrate. The last mentioned work was so thorough and admirable that the other researches are included here only for the sake of historical completeness.

Lamy† gives the results of one analysis of thallium sulphate and three of thallium chloride. 3·423 grms. Tl_2SO_4 gave 1·578 grm. $BaSO_4$; whence 100 parts of the latter are equivalent to 216·920 of the former. In the thallium chloride the chlorine was estimated as silver chloride. The following results were obtained. In the third column I give the amount of TlCl proportional to 100 parts of AgCl:—

3·912 grms. TlCl	gave 2·346	AgCl.	166·752
3·000 ,,	1·8015	,,	166·528
3·912 ,,	2·336	,,	167·466

Mean 166·915 ± 0·1905

Hebberling's‡ work resembles that of Lamy. Reducing his weighings to the standards adopted above, we have from his sulphate series, as equivalent to 100 parts of $BaSO_4$, the amounts of Tl_2SO_4 given in the third column:—

1·4195 grm. Tl_2SO_4	gave 0·6534 grm.	$BaSO_4$.	217·248
1·1924 ,,	0·5507 ,,	,,	216·524
0·8560 ,,	0·3957 ,,	,,	216·325

Mean 216·699

Including Lamy's single result, as of equal weight, we get a mean of 216·754 ± 0·1387.

From the chloride series we have these results, with the ratio stated as usual:—

0·2984 grm. TlCl	gave 0·1791	AgCl.	166 611
0·5452 ,,	0·3278	,,	166·321

Mean 166·465 ± 0·097

Lamy's mean was 166·915 ± 0·1905. Both means combined give a general mean of 166·555 ± 0·0865.

Werther's* determinations of iodine in thallium iodide were made by two methods. In the first series TlI was decomposed by zinc and potassium hydroxide, and in the filtrate the iodine was estimated as AgI. 100 parts of AgI correspond to the amounts of TlI given in the last column:—

0·720 grm. TlI	gave 0·51 grm.	AgI.	141·176
2·072 ,,	1·472 ,,		140·761
0·960 ,,	0·679 ,,		141·384
0·385 ,,	0·273 ,,		141·026
1·068 ,,	0·759 ,,		140·711

Mean 141·012 ± 0·085

In the second series the thallium iodide was decomposed by ammonia in presence of silver nitrate, and the resulting AgI was weighed. Expressed according to the foregoing standard the results are as follows:—

1·375 grm. TlI	gave 0·978 grm.	AgI.	Ratio 140·593
1·540 ,,	1·095 ,,		140·639
1·380 ,,	0·981 ,,		140·673

Mean 140·635 ± 0·016

General mean of both series, 140·648 ± 0·016.

From the foregoing results three values for the atomic weight of thallium are calculable:—

From the sulphate	Tl = 204·169 ±	0·166
From the chloride	,, = 203·879	0·126
From the iodide	,, = 203·886	0·054

In 1873 Crookes,† the discoverer of thallium, published his final determination of its atomic weight. His method was to effect the synthesis of thallium nitrate from weighed quantities from absolutely pure thallium. No precaution necessary to ensure purity of materials was neglected; the balances were constructed especially for the research; the weights were accurately tested and all their errors ascertained; weighings were made partly in air and partly in vacuo, but all were reduced to *absolute* standards; and unusually large quantities of thallium were employed in each experiment. In short, no effort was spared to attain as nearly as possible absolute precision of results. The details of the investigation are too voluminous, however, to be cited here; the reader who wishes to become familiar with them must consult the original memoir. Suffice it to say that the research is a model which other chemists will do well to copy.

The results of ten experiments by Professor Crookes may be stated as follows. In a final column we may state the quantitity of nitrate producible from 100 parts of thallium. The weights given are in grains:—

* Smithsonian Miscellaneous Collections. "The Constants of Nature."

† *Zeit. Anal. Chem.*, 2, 211. 1863.

‡ *Ann. Chem. Pharm.*, 134, 11. 1865.

* *Journ. f. Prakt. Chem.*, 92, 128. 1864.

† *Phil. Trans.*, 1873, p. 277.

324·963740	1142·569408	718·849078	130·3900
183·790232	1005·779897	766·133831	130·3912
190·842532	997·334615	748·491271	130·3920
195·544324	1022·176679	767·203451	130·3915
201·816345	1013·480135	750·332401	130·3897
295·683523	1153·947672	768·403621	130·3908
299·203036	1159·870052	769·734201	130·3917

Mean 130·3910 ± 0·00034

Hence, using the atomic weights and probable errors previously found for N and O, Tl= 203·715 ± 0·0365. If O=16, Tl=204·183.

Crookes himself, using 61·889 as the molecular weight of the group NO_3, gets the value Tl=203·642; the lowest value in the series being 203·628, and the highest 203·666; an extreme variation of 0·038. This is extraordinary accuracy for so high an atomic weight, at least as far as Crookes's work is concerned. But its value depends in reality upon the accuracy of other chemists in fixing the atomic weights of N and O; a slight variation in either of the latter constants producing a large variation here. What Crookes really has done has been to fix with almost absolute certainty the ratio between Tl and NO_3. If the latter group should have the molecular weight 62, in accordance with Prout's hypothesis, then Tl=204·008. In other words, the ratio thus fixed by Crookes is almost exactly represented by two whole numbers, and supports Prout's hypothesis in a very decided way. Crookes himself seems to have overlooked this fact, for he regards his results as militating against the hypothesis in question.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 6, 1883.

Dr. W. H. PERKIN, F.R.S., President, in the Chair.

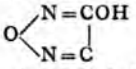
DURING the evening the following gentlemen were declared by the Scrutators of the ballot, Messrs. A. J. Greenaway and A. K. Miller, duly elected Fellows of the Society:—F. A. Blair, T. J. Barr, C. J. Baker, L. Briant, R. G. Durrant, Kamchaudra Datta, L. L. Garbutt, A. E. Harris, T. Hart, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. H. Rogers, C. W. Stephens, P. H. Wright, H. A. Wetzel, W. G. Whittam.

The following certificates were read for the first time:—B. H. Brough, G. Daubeney, C. C. Hutchinson, W. S. Kilpatrick, E. Matthey, J. W. Pallister, H. Peile, S. G. Rawson, W. Robinson, F. M. Rogers, R. Romanis, W. O. Senior, T. Stenhouse, J. A. Voelcker.

The following papers were read by the SECRETARY:—

"*On the Constitution of the Fulminates*," by E. DIVERS and M. KAWAKITA. The attention of the authors has been drawn to the chemistry of the fulminates, through the recommendation of mercury fulminate, by Steiner, as a source of pure hydroxy-ammonium chloride, a fact previously discovered by Carstanjen and Ehrenberg. The authors find that pure hydroxy-ammonium chloride, free from ammonia, is obtained by the action of strong hydrochloric acid on moist mercury fulminate, as stated by the above chemists; they find, however, that much hydrocyanic acid is also formed, although not a trace is produced if the fulminate be dry, a theoretical yield of hydroxy-ammonium chloride being obtained. This substance is strongly acid to litmus-paper. The authors ascertained that the whole of the carbon in mercury fulphide. They obtained the following numbers:—Mercury, 70·40 per cent; nitrogen, 9·85 per cent; carbon, 8·17 per cent. Not a trace of oxalic acid is produced in the above decomposition.

"*Theory of the Constitution of Fulminates*," by E. DIVERS. After discussing the various formulæ suggested by Berzelius, Kekulé, Armstrong, and Steiner, and a lengthy consideration of the formation, decompositions, and properties of the fulminates, the author gives the following as the probable constitution of fulminic acid:—



"*On Liebig's Production of Fulminating Silver without the Use of Nitric Acid*," by E. DIVERS and M. KAWAKITA. According to Liebig, fulminating silver separates in large needles and without ebullition when nitrous acid is passed into an alcoholic solution of nitrate of silver. The authors have repeated this reaction and obtained crystals, but they consisted of silver nitrate with a trace of some organic silver salt, which is not fulminate. A second experiment, in which silver nitrate and silver nitrite were added to alcohol and nitric acid (sp. gr. 1·35), then dropped in with shaking, also gave no fulminate. The authors conclude that even nascent nitrous acid, alcohol, and a silver salt do not yield a fulminate, but that an energetic oxidation of the alcohol by a mixture of nitric acid and either mercury or silver nitrate alone, seems to be effective. The paper concludes with an account of some unsuccessful attempts to form fulminating copper.

Dr. ARMSTRONG then read a short "*Note on the Constitution of the Fulminates*," by H. E. ARMSTRONG. In this note the author supports his previous views as to the constitution of fulminic acid, or rather a slight modification of them (HO.N)C.C.H(NO), against the criticism of Dr. Divers in the previous paper, and briefly considers the probable nature of the reaction between alcohol, nitric acid, and mercury. It is not probable that the fulminate is the immediate product of the action of nitrous acid (this note was written before the last paper of Divers and Kawakita was received) upon alcohol, and it is almost certain that alcohol, when treated with dilute acid, has its atoms of hydrogen displaced one by one by hydroxyl. Thus, a body having the constitution—

$$CH_2(OH).CH(OH)_2$$

is formed, and this body the author regards as the primary source of the fulminate which is formed by the simultaneous, or perhaps consecutive, action of nitrous acid and hydroxylamine.

Dr. GLADSTONE said it ought to be remembered that the formula of a substance depended to a great extent upon the reactions by which it is produced, and that it was often very difficult to find a formula which expressed all reactions. He should have liked the formula to have expressed more clearly the formation of sulphocyanide and urea by the action of ammonia and hydrogen sulphide.

Dr. ARMSTRONG said it was not possible to express all reactions in all cases, because the products were often not immediate, but formed by secondary decompositions.

The PRESIDENT thought some light might be thrown on the subject by investigating the secondary products of the oxidation of alcohol as to the formation of formic acid. It was very gratifying to receive communications from Japan, where the facilities for research must be small. Possibly such communications might serve as a stimulus to chemists at home to give a little more time to research.

The SECRETARY then read a paper entitled "*Experimental Investigations on the Value of Iron Sulphate as a Manure for certain Crops*," by A. B. GRIFFITHS. In a previous paper (*Chem. Soc. Journ.*, 1883, Abstracts, 496) the author gave the results of some experiments as to

the effect of iron sulphate on the growth of single plants. In the present paper he gives the results obtained on the large scale with plots of land near Bromsgrove, Worcestershire, with crops of beans and wheat. One plot was treated with commercial crystallised ferrous sulphate, 56 lbs. to the acre; the other was left in its normal state. The total weight of the dry crop (grain and straw) from the plot manured with ferrous sulphate was 5882 lbs.; from the normal plot 44·87 lbs. The former yielded 56 bushels of beans, the latter 35 bushels. The ash of the entire plant and of the pods in the plot manured with iron manure contained much more iron and phosphoric acid than those from the normal plot. The beans from the two plots exhibited but little difference in these respects. In the case of the wheat crops, although the iron manure produced much heavier and finer plants, the ashes did not show much difference as to iron and phosphoric acid. The author has also grown some plants in pots, exposing each pot to a different portion of the spectrum. The soil in which they grew contained ferrous sulphate. Those plants growing in the yellow yielded an ash containing 2·5 per cent Fe_2O_3; those in the violet 0·15 per cent Fe_2O_3.

Mr. WARINGTON said the paper contained many valuable facts, although some of the statements seemed to require modification or further investigation. There seemed to be no doubt that an increase of 21 bushels of beans was obtained by the addition of the ferrous sulphate. The author seemed to have overlooked the fact as to the increase of phosphoric acid, that one crop had many more pods than the other, and so the increase of phosphoric acid was only an increase in the relative number of pods. He was very sceptical as to the occurrence of crystals of ferrous sulphate, mentioned in this and the previous paper, in proximity to the chlorophyll granules.

The Society then adjourned to December 20, when a paper, "Researches on the Constitution of the Gums of the Arabin Class," by C. O'Sullivan, will be read.

PHYSICAL SOCIETY.

Saturday, December 8, 1883.

Prof. G. CAREY FOSTER in the Chair.

NEW Members:—Major McGregor, R.E.; Mr. James Walker, M.A.; Mr. W. B. Gregory, B.A.

Prof. SILVANUS P. THOMPSON, D.Sc., &c., read a paper "*On the Static Induction Telephone as an Instrument of Research.*" The author had employed Dolbear's telephone in investigating the action of influence machines, such as those of Holtz and Wimshurst, or Toepler. This was done by holding the end of a wire (connected to one terminal of the telephone) near the electrified parts of the machine: for example, the "carriers" in the Toepler apparatus. The carriers induced a charge in the telephone (whose other terminal was to earth) as they passed, and the pitch of the note heard in the telephone increased with the speed at which the machine was driven. Useful results were obtained, leading to modifications of some machines. The same telephone was also applied to the measurement of capacities of condensers arranged like the resistances of a Wheatstone Balance, and the telephone taking the place of a galvanometer. For the "divided coil" of the balance, Prof. Thompson substituted a double condenser, or rather two condensers, so joined that the earth plates were separate, while the other plates were in one. This device was made from two glass tubes with tinfoil round their outsides, and a brass tube sliding into both interiors in such a way that the relative capacities of the two condensers thus combined could be altered by sliding the tube between them. A modification of this plan was suggested by Mr. Starling, the author's assistant, which was analogous to Prof. Foster's arrangement of the Wheatstone balance; that is to say, six condensers were used, the two extra ones being included between the battery connections and the sliding tube. The battery was in this case an induction coil having no condenser, as a discontinuous current is necessary to give sounds. The author also showed that the Dolbear telephone could be used instead of the quadrant electrometer in such experiments as those of Mr. J. E. H. Gordon on specific inductive capacity. The author also showed how he had applied it to explore the equipotential surfaces round conductors charged statically by an induction current. With two wires from the terminals of a telephone silence is produced when both ends are on the same equipotential surface, and sounds when they are not.

Prof. THOMPSON then read a "*Note on a New Insulating Stem.*" This consisted of a glass tube with one end blown into a flat foot, which was planted on the bottom of a glass bottle, and cemented there by a little wax paraffin. The upper and open end of the tube served to hold the stems of brass plates, or other electrified bodies. Paraffin oil or strong sulphuric acid could be used in the bottom of the bottle. A cap of rubber or percha made to slide up the stem served as a dust cover.

Prof. THOMPSON next made a communication "*On the First Law of Electrostatics,*" and illustrated his remarks with experiments showing how a series of floating magnet poles of like name, repelling one another, tend to produce equal distribution of the poles. Prof. Thompson, arguing from the second law of electrostatics (inverse squares), sought to explain the first law in a rational manner, on the hypothesis of self-repelling molecules, which tend to uniform distribution. When there is a surplus in one part and a deficit in another, the molecules are urged towards each other, *i.e.*, attract. This was shown by putting a surplus of floating magnets at one part of the basin. By the movements of these magnets, when confined in barriers and with surplus and deficit purposely made, the author imitated the effects of a Leyden jar, induction, a battery current, &c., the motions and arrangement of the poles illustrating the hypothetical behaviour of electricity. The author was led by the hypothesis to infer that either the ether is electricity, or that the ether is electrified, and the former seemed the simpler conclusion.

Dr. MONKMAN showed some "*Experiments Illustrating the Attraction and Repulsion of Bodies in Motion.*" The attraction of a light balanced body to a vibrating tuning-fork was shown; also the attraction between two disks of paper revolving parallel and in the same direction. The author showed that two smoke-rings travelling abreast in the same direction attracted each other, and that two paper rings revolving in the same direction close together attract, while if revolving in the other direction they repel.

Mr. WALTER BAILY exhibited his new "Integrating Anemometer" in action by means of a small electric motor, which took the place of the Robinson cups. The apparatus sums up or integrates the wind velocities on the lines of the four cardinal points. An electric counter is attached.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, Dec. 3, 1883.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

HENRY BROWN, B.A., Oxon, James Duncan, F.C.S., William Thomas Sugg, C.E., Mrs. Mary Willis Tanner, Thomas Tyrer, F.C.S., were elected members of the Royal Institution.

Seven Candidates for Membership were proposed for election.

The decease of Sir William Siemens, Manager and Vice-President, on November 19th, was announced from the Chair.

The following resolution, passed by the Managers at their meeting this day, was read:—

theatre; he was our benefactor in presenting to us apparatus of great value; while his wise counsel, as a manager, was ever ready when the interests of the Institution required it. He showed his veneration for one of its Professors by naming a vessel—a model one of its kind—constructed under his personal supervision for the transport and laying down of telegraphic cables, 'The Faraday.' In everything he touched, practical genius, guided by a knowledge of principles not frequent among practical men, was displayed. In the domains of heat, electricity, and metallurgy he won his chief renown; and here the ultimate issues of his labours are at present incalculable. England, the land of his adoption, has lost through his death an engineer of singular power, penetration, and many sidedness. The source of the quality last mentioned, by which he was characterised, was, first of all, inherent ability, and, secondly, the comprehensive scientific education which he received in the seminaries and universities of his native land. He came to us thoroughly equipped with the theoretic knowledge necessary for practical ends, and he applied that knowledge successfully in the most varied spheres of action. As regards invention he came of a family to the manner born: all his brothers, and especially his eldest brother, the celebrated Dr. Werner Siemens, having achieved distinction in applying science to the uses of life. William Siemens was a man of the most charming disposition, genial, kindly, without jealousy or bitterness, and as a natural result he secured not only the respect but the warm affection of those who intimately knew him. The members who were present on the occasion of our last monthly meeting will not readily forget the animated description he then gave us from the chair of a new application of steam power which he had just seen tried on the River Spree, near Berlin. How little could the freshness and the vigour of that exposition prepare his hearers for the catastrophe so soon to follow! Among the members of the Royal Institution he has left many mourning friends, who profoundly sympathise with his family in their great bereavement, and more especially with Lady Siemens in her irreparable loss."

The following lecture arrangements were announced:—

Professor Dewar, M.A., F.R.S., M.R.I.—Six Experimental Lectures (adapted to a Juvenile Auditory) on Alchemy (in relation to modern Science); on Dec. 27 (Thursday), Dec. 29, 1883; Jan. 1, 3, 5, 8, 1884.

Reginald Stuart Poole, Keeper of Coins, British Museum.—Two Lectures on the Interest and usefulness of the Study of Coins and Medals; on Tuesdays, Jan. 15, and 22.

Ernst Pauer, Principal Professor of the Pianoforte at the Royal College of Music.—Six Lectures on the History and Development of the Music for the Pianoforte and its Predecessors, the Clavecin, Harpsichord, &c. (with Musical Illustrations on these Instruments); on Thursdays, Jan. 17 to Feb. 21.

Professor Tyndall, D.C.L., F.R.S., M.R.I.—Six Lectures on The Older Electricity: its Phenomena and Investigators; on Thursdays, Feb. 28 to April 3.

Archibald Geikie, F.R.S.—Five Lectures on Tuesdays, Jan. 29 to Feb. 26.

Professor John G. McKendrick, M.D., F.R.S.E., Prof. Inst. of Med. Univ. of Glasgow, Fullerian Prof. of Physiology, R.I.—Five Lectures on Animal Heat: its Origin, Distribution, and Regulation; on Tuesdays, March 4 to April 1.

Professor Henry Morley.—Six Lectures on Life and Literature under Charles I.; on Saturdays, Jan. 19 to Feb. 23.

Captain W. De W. Abney, R.E., F.R.S., M.R.I.—Six Lectures on Photographic Action, considered as the Work of Radiation; on Saturdays, March 1 to April 5.

NOTICES OF BOOKS.

Letts and Co.'s Diaries for the Year 1884.

THE firm of Letts, Son, and Co., Limited, still hold a decided pre-eminence in the production of diaries adapted to the most varied tastes, requirements, and circumstances of the public. The specimens before us range in size from the sturdy folio, fit for the desk of the merchant or manufacturer, to the neat gilt-edged volume for the pocket. The space devoted for each day varies from an entire page down to one-seventh of a page.

Among those editions which more particularly call for notice ranks the "Medical Diary," an elegant pocket volume. It contains an almanac adapted for entering the meetings of societies, tables for comparing thermometric degrees, instructions for restoring the apparently drowned, scales of professional fees; a list of poisons and their antidodes, in which, by the way, the soluble compounds of chromium are omitted; new drugs and remedies; a classified list of medicines; tables of normal weight of the human body; spirometry; therapeutic equivalents, hypodermic injections; temperature of baths; saturation-tables, chemical reactions of morbid urines, list of formulæ, &c., as well as useful information of a more general character, such as postal regulations. If we may venture a suggestion, it strikes us that a useful additional feature in this, and in every other diary intended for professional or other scientific men, would be a list of the regular meetings of the learned societies, which might be introduced into the almanac.

An examination of this diary brings under our notice an unsatisfactory point in the scale of fees for medical men when called upon to appear as experts in a court of law. We do not here claim in any way to speak on behalf of the medical profession, which has its own recognised organs. But we feel that the scale thus laid down may be held in certain points binding upon analytical chemists. It appears that the fee for making a post-mortem examination, which, according to the coroners' summons as quoted may include an analysis of the contents of the stomach, is one guinea! We are certain that in many cases ten guineas would be a barely sufficient remuneration for several days of exceedingly delicate work, requiring for its performance great skill and wide experience, and the consumption of a considerable quantity of absolutely pure, and therefore costly, reagents.

A curious form of diary is the "Monthly." In this kind, each month forms, for convenience of carriage, what may be called a separate pamphlet, the whole of which are ordinarily contained either in a book-like box, or in a morocco wallet.

The "Appointment Diary" is intended to provide "an hourly arrangement for the punctual keeping of engagements, especially those of professional persons, lecturers, and students." After an almanac, of somewhat mediæval character, and other usual information, follow certain blank pages for memoranda, &c. In the main part of the diary we see the days of the month, seven to the page on the left hand side, and on the right the corresponding days of the week placed as headings, whilst in the margin stand the hours of the day from 9 a.m. to 8 p.m. The engagements of the coming day, or week, are thus shown at a glance. This seems a very convenient arrangement. The book is of pocket size; it is issued in three different styles of getting up, and might, if needed, be brought into still smaller compass by omitting certain matter which, however generally useful, does not seem here particularly apposite.

The "Metallic Diary" is an elegant little book giving

a week on two opposite pages. At the end of some months, but not of others, follow a few blank pages, we presume for memoranda.

In this edition there is no printed matter beyond the almanac at the beginning.

The Housekeeper gives as its specialities a table of articles of food in season; tables for checking bills, times of high water; an alimentary table, in which we regret to find blood classed as an article of food; a register of rates and taxes, formidable in number; servants' engagement register; household gas register, wine register; addresses or memoranda; register of articles lent, &c. The bulk of the book is devoted to a classified account of daily expenditure. In this, and apparently in all the editions of the octavo and quarto series, Messrs. Letts still insert the least satisfactory feature of their diaries, their "concise directory," the exceptionable character of which we have pointed out on a former occasion.

The "Commercial Tablet Diary" shows an entire week at a glance, and is so arranged that it may be suspended by a loop, the weeks that are passed being turned over backwarks.

As favourable specimens of the commercial or office diary may be taken the 8vo. No. 8 and the folio 51. When it is remembered that those editions which we have specially mentioned are merely specimens out of a great number, each bearing some distinctive feature, the enterprise of Messrs. Letts in meeting the wants of the public will be duly appreciated.

CORRESPONDENCE.

THE DIRECT UNION OF NITROGEN AND HYDROGEN.

To the Editor of the Chemical News.

SIR,—In a paper published in the CHEMICAL NEWS (vol. xlviii., p. 187) I brought forward a criticism on the statement of Mr. Stillingfleet Johnson, that nitrogen and hydrogen united directly under the influence of heated spongy platinum. I showed that hydrogen passed through a solution of silver nitrate, yields ammonia when passed over heated spongy platinum, by reacting with the nitric oxide produced by the decomposition of silver nitrate. Mr. Johnson, in the succeeding number of the CHEMICAL NEWS, stated that he had obtained ammonia when silver nitrate was not used to purify the hydrogen. He was kind enough to send me a copy of his paper read before the Royal Society in 1881, in which these experiments were described. The nitrogen was prepared by passing air over sawdust coated with freshly precipitated ferrous sulphide, and allowing the gas so obtained to stand over water containing ferrous ferrocyanide in suspension. It was purified by passing (1) through a U tube containing fragments of caustic potash; (2) through strong sulphuric acid; (3) through alkaline pyrogallate of potash. The hydrogen was prepared from zinc and dilute sulphuric acid, and purified by chromic and sulphuric acids. The mixed gases were passed through a set of bulbs containing Nessler's solution, over heated spongy platinum, and through a second set of bulbs containing Nessler's solution. Mr. Johnson found that it was possible to get 1·5 milligrms. of ammonia from 10 litres of nitrogen. I repeated these experiments and found that ammonia was produced from the gases prepared and purified in the way that Mr. Johnson described. I found, however, that the length of time during which the nitrogen was exposed to the action of the ferrous ferrocyanide had an influence on the amount of ammonia produced. The gas which had stood over the ferrocyanide for three days gave about twice as much ammonia as the gas which had only stood for six hours. To see what effect was produced by the omission of the shaking up with ferrocyanide in the process, I filled a gas-holder with the gas prepared by drawing air, bubble by bubble, through a long tube containg sawdust and ferrous sulphide. The removal of oxygen was completed by passing the gas through alkaline pyrogallate. With this gas slight traces of ammonia were produced, when it was mixed with hydrogen and passed over heated spongy platinum. This experiment shows that when the nitrogen is allowed to stand over ferrous ferrocyanide, some substance is given up to it, which will produce ammonia when passed over heated spongy platinum. The gas prepared from air by shaking up with ferrous ferrocyanide in suspension in water, gave ammonia when it was passed over heated platinum without any admixture of hydrogen.

I have prepared nitrogen in four different ways without the use of heat, to see if any "active" nitrogen could be obtained from the air by methods which involved the use of no agent containing combined nitrogen. The oxygen of the air was absorbed (1) by cold moist phosphorus; (2) by an alkaline solution of pyrogallate of potash; (3) by water holding ferrous hydrate in suspension; (4) by a solution of sodium zinc hyposulphite, prepared by dissolving zinc in a solution of sodium hydrogen sulphite. The nitrogen from these sources gave no ammonia when mixed with hydrogen and passed over heated spongy platinum.—I am, &c.,

H. BRERETON BAKER.

Balliol College, Oxford.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvii., No. 21, November 19, 1883.

Volcanic Phenomena of the Straits of Sunda.—M. Daubrée.—The ashes thrown out contain soluble chlorides in considerable quantity. If heated in a closed tube they give a white deposit, giving off a little water with a very acid reaction and a slight bituminous odour. The white matter on oxidation gives off a sulphurous odour. Mineralogically the ash consists of octahedral crystals of ferrous oxide, small black fragments of pyroxene augite, a great number of transparent fragments of hypersthene, colourless crystals of felspar, and crystals of pyrites.

Purple Dye of the Ancients, according to a Fragment attributed to Democritus.—M. Berthelot.—The author states that the works of Democritus or of his disciples formed a kind of philosophical and scientific encyclopædia, which was collected and arranged in Tetralogies by Thrasyllus, in the reign of Tiberius, but which has unfortunately been lost, with the exception of some fragments collected and published by Franck in 1836, and by Mullach in 1843. M. Berthelot, whilst examining the Greek alchemical manuscripts in the National Library, found the fragment in question given in the original Greek, and in the following version:—

"Putting in a pound of purple, ... place it on the fire until ebullition; then, removing the decoction from the fire, put the whole into a vessel, and, withdrawing the purple, pour the decoction upon the purple, and let steep for a night and a day. Then, taking 4 lbs. of orchil, pour water upon the weed to the depths of four fingers, and let it become thick. Filter, heat, and pour upon the wool. Let steep for two nights and two days. Take out and dry in the shade; and to 2 lbs. of the liquor add water so as to make up the original quantity. Repeat until it becomes thick; then, having filtered, re-enter the wool as before, and let it steep for a night and a day. Lift and rinse in urine, and dry in the shade. Take *laccha* (probably alkanet), put it with 4 lbs. of sorrel, and boil with

urine till the sorrel is reduced. Having clarified the water, put in the alkanet, boil until thick, filter again, enter the wool, then wash afresh with urine, and afterwards with water. Dry in the shade, and expose to the vapour of sea-weeds steeped in urine. . . . . The following wares enter into the composition of the purple:—The weed which is called false purple, the coccus (a kind of cochineal), the sea colour (orchil), the crismos (?), alkanet, Italian madder, the phyllanthion of the divers, the "purple worm" (probably another sort of cochineal), the rose of Italy. These colours are esteemed by our predecessors. There are colours to be avoided and which are of no value: The cochineal of Galatia, the colour of Achaia, which is called laccha, that of Syria, called rhizion (an inferior madder?), the shell-fish of Libya, and of the coast of Egypt, called pinna, the woad of the upper region, and the colour of Syria called murex. These colours are not fast, and, except woad, are not esteemed among us."

[The obscurity of this passage is in great part due to our ignorance of the technical terminology of the Greek language.]

Production of very Low Temperatures by Means of Continuous Apparatus.—M. Cailletet.—The author has sought to utilise the intense cold produced by the release of compressed gases. He has arranged a cylinder of steel, perfectly air-tight, containing a worm formed of a copper tube, the two ends of which project outside the apparatus. In this cylinder, and upon the worm itself, is effected, by means of a cock of special construction, the release of the ethylene previously condensed in a metallic receiver. Two tubes of copper, secured by screws, penetrate into the cylinder. One of these tubes is in communication with the suction-valve of the author's mercurial pump, which acts as a pneumatic machine, giving a vacuum almost absolute. The second tube receives the ethylene compressed by the pump and brings it, refrigerated by methyl-chloride, above the releasing-cock.

Electro-Chemical Energy of Light.—F. Griveaux.—The author substitutes the measurements of the electromotive forces developed for that of the intensity of the currents produced. His researches have been directed to the following points:—(1.) Given the same plate and the same luminous source, what is the influence of the distance between them? The comparison of the sources as to their illuminating power and their electro-chemical energy. (2.) Influence of the superficial extent of the sensitive plate. (3.) Influence of the thickness of the layer of the salt of silver. (4.) Effects produced by the same quantity of light falling upon plates of different extent, but prepared identically. (5.) Influence of the nature of the light. The relation between the electro-motive force developed and the wave-length of the simple light employed. The numerical results will be communicated in a future memoir.

Action of Carbonic Acid upon Calcareous Saccharine Solutions.—D. Loiseau.—The presence of calcium carbonate in a solution opposes the precipitation of the saccharates of the same base. The saccharate and the carbonate keep each other mutually in solution.

A New Ureometer.—W. H. Greene.—The author describes and figures a new apparatus for the rapid approximate determination of urea in urine.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xii., Part 10.

Examination of Corpuscules suspended in Water.—E. Marchand.—From the *Comptes Rendus*.

Influence of the Salts of Sea-water upon Fresh-water Animals, and Cause of the Death of Fresh-water Animals in Sea-water and of Sea-water Animals in Fresh-water.—H. de Varigny and P. Bert.—From the *Comptes Rendus*.

Researches on Different Kinds of Humoid Soils and on their Behaviour with Water.—Prof. A. Emmerling.—An examination of three specimens of moorland soils.

Proportion of Carbonic Acid in the Atmosphere.—A. Muntz and E. Aubin.—The substance of this paper has appeared in the *Comptes Rendus*, vol. xcvi., p. 1796.

Manurial Value of Dried Blood.—Prof. A. Petermann.—Dried blood was tried in comparison with doses of soda saltpetre containing approximately equal quantities of nitrogen, alone, along with phosphoric acid, and again along with phosphoric acid and potash. The experiments were performed both on sandy and clayey soils. The value of the dried blood was found less than that of soda saltpetre, both when used alone, and when applied conjointly with phosphoric acid and potash. The sources of nitrogen appear to hold the following positions in respect to their efficacy. Soda saltpetre, dried blood, dissolved wool, crude wool, and ground leather.

Manurial Experiments upon Potatoes, Beets, and Maize.—A. Nantier.—With potatoes, the author finds that superphosphate and precipitated phosphate were most efficacious in increasing the yield. Upon beets the action of precipitated phosphate was in every respect more beneficial than that of superphosphate. Maize seemed to derive the greatest benefit from farm-yard manure.

Manurial Experiments at Löwitz.—Count Von Schwerin.—Organic nitrogen was found much less efficacious than soda saltpetre.

Experiments on Four-Years' Rotation.—Dr. A. Voelcker.—From the *Journal of the Royal Agricultural Society*.

A Silesian Farm without Cattle.—M. Fischer.—The author finds the exclusive use of artificial manures more advantageous and more effectual, except for rape.

Chemistry of Glutine.—H. Weiske.—Collagen is the more readily converted into glutine the poorer it is in mineral matters. If such substances are completely removed, a solution of glutine is obtained, which, unlike ordinary glutine, is not precipitated by tannin unless a few drops of a solution of sodium chloride are simultaneously added.

Experiments and Observations on Various Diseases of Cattle.—A summary of the results of Pasteur and others on rabies and on protective inoculation in case of sheep-pox and pleuro-pneumonia.

Value of Wheat-bran for Human Diet.—Dr. Max Rübner.—The finest flour represents only 30 per cent of the grain of wheat; the medium qualities about 70 per cent. Comparative experiments were tried with bread made respectively from such flours and from the wheat-meal of the Bread Reform League. The larger the proportion of bran left in the flour the more nutritious matter remains unassimilated, and is excreted. The author considers that bran might be made more assimilable by being more finely ground. He doubts, however, the economy of the proposal, since at present bran serves for the food of animals which are able to digest and assimilate it much more completely.

Studies on Milk.—H. Struve.—From the *Journal für Praktische Chemie*.

Effects of Cotton Seed Cake upon the Yield of Milk.—The result of the experiments made upon six cows showed an advantage in the use of the cake.

Influence of Radiant Heat upon Parts of Plants during Growth.—J. Wortmann.—Curvatures may be induced in growing plants by the influence of radiant heat applied unilaterally, the inclination being sometimes towards, sometimes away from, the source of heat.

Artificial Modification of Internal Causes of Growth.—Prof. E. Wollny.—These two papers do not admit of useful abstraction.

Sequel to Studies on Evaporation. — Dr. Paul Sorauer.

Composition of the Barley produced in the Province of Saxony.—Prof. Mærcker.—The value of the Saxon barley for brewing purposes is ascribed to its small proportion of nitrogenous compounds.

Justus Liebig's Annalen der Chemie, Band 220, Part 3.

Communications from the Chemical Institute of Marburg.—These consist of a paper by Paul Senff on meta-benzyl-toluol, meta-tolyl-phenyl-keton, meta-benzoyl-benzoic acid, and their reduction-products; a memoir by W. Roser, on terebic acid, and another by the same author, on iso-propyl-succinic acid or pimelic acid.

Gluconic Acids of Different Origin.—A. Herzfeld.—The author's immediate object is to ascertain if the gluconic acid from maltose is identical with the dextronic or gluconic acid of Hlasiwetz and Habermann. He concludes that dextronic, maltonic, and gluconic acids are identical. It is indifferent whether bromine or chlorine is used for the preparation of gluconic acid, and likewise if silver oxide or another metallic oxide or carbonate is used for the decomposition of the halogen compound. The gluconic acid obtained is always the same. On oxidation with bromine saccharic acid always appears along with gluconic acid. Gluconic acid does not reduce Fehling's solution; it is mono-basic.

Remarks on Benzo-quinone. — O. Hesse. — The author opposes the view of Scheid that benzo-quinone contains a hydroxyl.

Vol. 221, Part 1.

Different Chemical Behaviour of the Aromatic Diamines.—Eugen Lellmann.—The author first describes the preparation of the diamines, and then proceeds to consider the behaviour of the sulphocyanides of the aromatic diamines, of the corresponding cyanates, the reduction of the ortho-nitrised anilides and toluides of benzol-sulphonic acid, and the action of the mustard oils upon the diamines.

Communications from the Chemical Laboratory of the University of Jena.—These consist of a memoir by Dr. Max Schrœder on the action of carbon monoxide in presence of salts whose acids belong to different series; a paper by A. Geuther on the action of phosphorus trisulphide upon phenol and cresol, and an essay by the same author upon certain new derivatives of mannite.

Examination of Saturated and Non-saturated Esters and Certain Allied Compounds.—F. Veger.—This paper does not admit of useful abstraction.

The Chemical Affinity of Certain Groups of Compounds deduced from their Density, and the Changes in Volume on the Neutralisation of Aqueous Solutions.—W. Müller-Erzbach.—Judging from the density of the compounds, phosphorus, boron, and silicon have a greater affinity for chlorine than for bromine. In accordance with relations of volume, and in accordance with the known behaviour of the compounds, we find the affinity of chlorine decidedly feebler than that of iodine. Potassa and soda, when neutralised with nitric, sulphuric, and hydrochloric acids, undergo a contraction which is masked by the presence of large quantities of water, and converted into expansion.

Chloride of Lime and Chloride of Lithia.—K. Kraut.—A reply to Dr. G. Lunge's memoir published in Vol. 219, p. 129, of these *Annalen*. The author discusses Dr. Lunge's paper at considerable length, and gives in conclusion his own view. He considers chloride of lime as a mixture of equal mols. of calcium chloride and hypochlorite. The third mol. of lime unites with one of these salts to form a basic salt, the formation of which is the cause that not 6, but only 4, atoms of chlorine act upon 3 mols. of hydrate of lime.

Vol. 221, Part 2,

Certain Bromine Substitution Products of Ethan and Ethylene.—R. Anschutz.—The results of the author's studies on the bromised ethans and ethylenes may be summarised as follows: — Dibromethylene, in which Demole observed conversion into brom-acetyl-bromide by the direct addition of oxygen, has an unsymmetric formula, and is acetyliden-dibromide. There are known at present only two isomeric tetra-brom-ethans, which are clearly distinguished from each other by their physical properties. Their boiling-points and specific gravities differ when determined under identical circumstances. Only the non-symmetric halogen derivatives of ethan, ethylene, and acetylene seem to exhibit phenomena of polymerisation. Between any two bromised ethans the difference of the boiling-points is the same as between the two corresponding bromised ethylenes. Among the isomeric bromised ethans and ethylenes, the non-symmetric compound has a lower specific gravity than the symmetric. The specific gravities of the bromised ethans are smaller than those of the corresponding ethylene compounds.

Meta-iso-cymidine.—Werner Kelbe and Constantine Warth.—The authors describe nitro-meta-iso-cymol, its oxidation, the formation of nitro-toluylic acid, and the barium salt of the latter; meta-iso-cymidine, its sulphate, oxalate, and platinum double salt; acet-meta-iso-cymidide, nitro-benzoyl-meta-iso-cymidide, benzoyl-iso-cymidide; the oxidation of benzoyl-meta-iso-cymidide, meta-iso-cymidine, its oxidation to amido-meta-toluylic acid; phthal-meta-iso-cymidide, nitro-phthal-meta-iso-cymidide, meta-iso-cyminyl-carbyl-amine; certain substituted ureas such as meta-iso-cyminyl-urea, the corresponding di-compound, meta-iso-cyminyl-urethan, di-meta-iso-cyminyl-thio-urea, meta-iso cyminyl-ethyl-thio-urea, meta-iso-cyminyl-ethyl-guanidine, tri-benzoyl-meta-iso-cyminyl-ethyl-guanidine, nitro-meta-iso-cymidine, sulpho-meta-iso-cymidic acid, and its barium salt.

Communications from the Chemical Laboratory at Greifswald.—These consist of a memoir by Dr. O. Kornatzki on certain di-sulpho-azo-toluolic acids, and on a para-di-sulpho-toluolic acid; a paper by H. Limpricht on the behaviour of the amides of certain sulpho-acids with nitrous acid. This subject is worked out by F. Hybbeneth as regards the amide of meta-sulpho-amido-benzolic acid; by Dr. A. Heffter for the amide of ortho-sulpho-para-amido-toluolic acid, and by W. Paysan for the amide of para-sulpho-ortho-amido-toluolic acid. Lastly follows a memoir by G. Mohr on benzyl-sulphonic acid.

Carboxy-tartronic Acid and the Constitution of Benzol.—Aug. Kekulé.—A voluminous defence of the author's views on the constitution of benzol.

MISCELLANEOUS.

Erratum.—In the continuation of Mr G. Stillingfleet Johnson's article on "Electro-Chemical Researches on Nitrogen" (vol. xlviii., p. 264), Fig. 5 should be Fig. 3, Fig 3 should be Fig. 4, and Fig. 4 should be Fig. 5.

New Views of Chemical Philosophy.—Professor J. P. Cooke, of Cambridge, commenting upon some views recently expressed by Boutlerow, the eminent chemist (which views relate to the variability of the law of definite proportions, and which are endorsed by Schutzenberger), remarks:—"Such opinions are certainly very revolutionary, and, if they prevail, must entirely change the fundamental conceptions of chemical philosophy. Chemical combination can no longer be regarded as the juxtaposition of the definite invariable masses we call atoms, but must be considered as the "reciprocal saturation," or "interpenetration," of masses which may vary with the relative strength of their chemical energy acting at the time; and this change of the fundamental conception is

There is, in fact, nothing new about them; for it is well-known among chemists in this country, that Cooke not only expressed these views twenty-five years ago, but he worked them out in the laboratory, and presented to the American Academy in 1855 memoirs which fully developed all that is now claimed as new by the German chemist. The paper published by Cooke "On Two New Crystalline Compounds of Zinc and Antimony, and on the Cause of the Variation of Composition observed in their Crystals," goes over the whole ground, and calls attention to the order of variation in the composition of certain well-defined crystals obtained from alloys of zinc and antimony, of different percentage composition, by the method of "fusion." It is difficult to understand how so well-informed and painstaking a chemist as Boutlerow could have overlooked Professor Cooke's researches. He is certainly anticipated in his discoveries by at least twenty years, and it becomes him to place himself in rightful position. The extended and careful researches of Professor Cooke do not lead him to doubt the correctness of the atomic theory; and the assumption of the existence of molecules and atoms forms an hypothesis upon which all the perplexing phenomena observed can be explained. The variation in the proportions of constituents of a crystallised compound without any change in the crystalline form, he proposes to designate as examples of "allomerism." Probably no investigator in the past quarter of a century has conducted so elaborate a series of experiments, with the view of proving or disproving the correctness of the atomic weights, as Professor Cooke, and this line of difficult research is still in progress at the Cambridge laboratory. He states that he has found no problem of chemistry more difficult than to prove that the materials and products involved in atomic weight determinations are perfectly pure, and represent a condition in which the elements are united in the definite proportions sought. The weight of evidence is at present in favour of the atomic theory; but we must not forget that chemical philosophy as now understood does not rest upon the impregnable basis of demonstrated fact. Professor Cooke is forced to admit, that while he regards the weight of evidence in favour of the atomic theory, and that it is the only basis on which a consistent philosophy of chemistry can at present be built, still he is rather drawn to that view of nature which *refers all differences between substances to dynamical causes*, and which regards the atomic theory as only a temporary expedient for representing the facts of chemistry to the mind. This is essentially the view of most of the able chemists now living, and it leads irresistibly to the conclusion that the mysteries surrounding what we call matter are as impenetrable as those connected with mind, soul, or spirit.—*Popular Science News.*

MEETINGS FOR THE WEEK

MONDAY, Dec. 17th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "The Scientific Basis of Cookery," By W. Mattieu Williams, F.C.S.
TUESDAY, 18th.—Institute of Civil Engineers, 8. (Anniversary.)
—— Pathological, 8.30
WEDNESDAY, 19th.—Society of Arts, 8. "Canada and its Products," by the Most Hon. the Marquis of Lorne, Kt., late Governor-General of Canada.
—— Meteorological, 7.
—— Geological, 8.
THURSDAY, 20th.—Royal, 4.30.
—— London Institution, 7.
—— Chemical, 8. "Researches on the Constitution of the Gums of the Arabin Class," by C. O'Sullivan. "On the Decomposition of Ammonia by Heat," by Dr. W. Ramsay and Sydney Young. "On the Dissociation of the Halogen Compounds of Selenium," by Dr. W. Ramsay and F. P. Evans.

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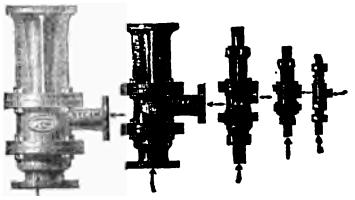

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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1256.

THE WAVE-LENGTHS OF A, a, AND OTHER PROMINENT LINES IN RED AND INFRA-RED OF THE VISIBLE SPECTRUM.*

By Captain ABNEY, R.E., F.R.S.

M. FIEVEZ has recently sent me a map of the solar spectrum from C to A† inclusive, and as part of this region is one which I am measuring for a new photographic map of the whole solar spectrum in conjunction with Professor Rowland, I have examined the new publication with great interest. Photography and eye measurements do not exactly coincide in the detail of the grouping of the little *a* group as far as A, and A itself is shown by M. Fievez's map as wanting in some details which appear in the photographs. Thus in the photographs there are some nineteen lines, whilst in M. Fievez's map there are but thirteen. Between A and *a* there are several lines of marked intensity in the photograph which are not shown in the new map. The wave-lengths of the different lines from above "*a*" to A are not those given by Fievez, when comparison photographs of the first order of the red and second of the ultra-violet were taken on the same plate, which were again checked by photographs of the second order of the red with the third order of the green taken in a similar manner. In my Bakerian Lecture for 1880 on the "Photographic Method of Mapping the Least Refrangible End of the Spectrum," I gave a method of using mirrors by which this could be effected, but since Prof. Rowland introduced his concave gratings this is much more readily carried out. He has kindly furnished me gratings for the purpose, and having about 14,400 lines to the inch, with focal distances of 7 feet 6 inches and 12 ft. 6 ins. respectively. These have been employed in determining the wave-lengths of this part of the spectrum. Cornu's map was used as a reference for the ultra-violet wave-lengths, and Angström's map for those in the blue and green.

Descript'n of line.	λ from comparn. of 1st and 2nd orders.	λ from comparison of 2nd and 3rd orders.	λ according to Fievez.	Remarks.
"a"	{7184·4 7185·4	7184·5 7185·4	7197·7 7198·7	This is shown in Angström's map as a single line λ 7184·9.
Most refrangible edge of A.	7593·6	7593·7	7600·0	Angström gives 7604 for the centre of this line; which of the bands he took as A is not clear. Langley gave 7600·9 for this edge.
Centre of 6th pair of lines in the flutings following A.	7644·2	7644·33	7652·2	

The determination of A has been made by Mascart, Smythe, and others, besides Angström and Langley, with discordant results. I think the above may be taken as accurate as are Cornu's and Angström's maps,

It may be useful to forestall the map by giving the wave-lengths of a few of the principal lines in the infra-red. The first four have been seen and measured by Professor Piazzi Smyth. The scale-numbers refer to my map of the infra-red, which is published in the *Phil. Trans.*, Part II., 1880.

Scale No.	Description.	Wave-lengths.
1046	This line is a double, of which the components have the accompanying wave-lengths..	8226·4 8229·9
1441	.....	8496·8
1509	.....	8540·6
1685	.....	8661·0
2175	A double line, the components of which have the accompanying wave-lengths	8986·2 8989·5
2638	" " "	9494·5 9500·1
3161	.....	9633·8

The measurements of the lines have been made with a micrometer by Hilger. The $\frac{1}{100}$ of an inch can be easily measured, and in extreme cases the $\frac{1}{1000}$ of an inch can be recognised.

LEAD-CHAMBER DEPOSIT FROM THE BRIMSTONE SULPHURIC ACID OF JAPAN.*

By EDWARD DIVERS, M.D., and MASACHIKA SHIMOSÉ.

SULPHURIC acid is made in Japan exclusively from brimstone or volcanic sulphur, no pyrites or sulphur prepared from it being employed.

The deposit we received from the sulphuric acid works of the Imperial Japanese Mint at Osaka, had been cleaned out of the lead chambers in the form of a slime or mud. It settled on standing into a pale yellow, supernatant liquor, and a sediment of grey-red colour with many bright yellow particles. The liquor was sulphuric acid, impure, and very dilute, of sp. gr. 1·15. Its colour was due to ferric sulphate present in not inconsiderable quantity. We obtained from 1 litre of the liquor:—

Tellurium	0·37 grm.
Selenium	0·15 "

and also a trace of arsenic.

The sediment drained of its mother-liquor as far as practicable upon a filter, and dried in the sun without previous washing, weighed two-thirds of the whole deposit. It was in this state analysed to the extent shown by the subjoined table:—

Selenium, free and combined	10·5
Tellurium, " "	1·2
Sulphur, uncombined	6·5
Arsenic	doubtful trace
Mercury, uncombined	0·016
Copper	trace
Molybdenum	trace
Lead sulphate	29·5
Silicious ash and earthy matters	24·5
Hydrogen sulphate Water, principally Organic matter, a little Ferric sulphate, a very little	by diff. .. 27·8
	100·016

The proportions of selenium and tellurium in acid liquor and sediment were, as will be seen, reversed. The cause of this was the oxidisability of moist, finely-divided tellurium by air, particularly in the presence of an acid.

* A Paper read before the Royal Society, December 6, 1883.

† *Annales de l'Observatoire Royal de Bruxelles*, nouvelle série, t. v.

* Communicated by the authors. Some of the facts described in this paper have been made known already at meetings of the British Association.

Kastner. The deposit when we obtained it had suffered much exposure, and we believe that we should have found in it, if it had not been thus exposed, much more tellurium than we did.

When the sediment was distilled in a clay retort, there came over at first much water and sulphur dioxide, next a bright yellow sublimate in small quantity, apparently impure sulphur; then much selenium and tellurium; and, lastly, selenious oxide—sulphur dioxide escaping all along. Somewhat unexpectedly the whole of the tellurium came over, as well as all the selenium. The retort contained, among the other fixed matters at a distance from its hot sides, some very well crystallised galena, formed by the reducing action of the sulphur and selenium upon the lead sulphate.

The composition of this deposit is remarkable for several of its details. Taking the presence of *ten per cent of selenium* first, this selenium is in itself common enough in deposits from chambers making vitriol from Harz pyrites (Lunge), and even in such quantity, but it is here peculiar in being present in a deposit in chambers fed with nothing but brimstone gas.

Tellurium has not previously been found at all in lead chambers. We announced in 1881 (CHEMICAL NEWS, vol. xliv., p. 229), the occurrence of tellurium in Japanese sulphuric acid, then found we believe for the first time in any sulphuric acid.

Mercury, as a constituent of the deposit in chambers where Harz pyrites is burnt, is incidentally noticed in Lunge's "Sulphuric Acid," pp. 584-5, when Otto's process for getting selenium from the deposit is described. But here, as remarked of the presence of selenium, there is the peculiarity of its occurring where only brimstone—volcanic sulphur—is employed. All the attempts that we have had made to detect mercury in volcanic sulphur from different localities in Japan, have been unsuccessful. We included in our examination, samples of the sulphur in use at the works, which was not, however, part of any stock long in use there, and consequently not with certainty of exactly the same kind as that burning when the mercury had been deposited. In testing for mercury in the sulphur we used such quantities as 20 grms., dissolved in potassium hydroxide, and oxidised by chlorine. We are indebted for part of this testing to Mr. Iwaichiro Shidzuki, and also for the estimation of the mercury in the chamber deposit. Our assertion that the mercury was in the uncombined condition is based upon the fact that whereas the deposit readily gave up the mercury to dilute nitric acid, it entirely refused to do so to potassium cyanide solution.

Copper is so common that the trace of it found in the deposit is perhaps not so remarkable as that of mercury.

Molybdenum is here found in chamber mud probably for the first time, and is remarkable for being present under the circumstances. We obtained a little burner-ash, and found in it some molybdenum oxide and a very small quantity of tellurium oxide. The ash was a soft, light, pale yellowish grey substance.

The sulphur present in the elemental state was not intimately diffused through the deposit, but formed very distinct pellicular particles of a bright orange-yellow colour. Its colour was due no doubt to the presence of selenium and tellurium in combination with it, and its form seemed to have resulted from the tearing up of a film.

The sediment readily, though very imperfectly, sorted itself on elutriation into lead sulphate, grey and slimy, at the bottom; coarse, whitish, friable particles of ash and particles of sulphur next; and, at the top, exceedingly fine particles of red impure selenium.

We have had many gallons of the mud in our possession, and know, therefore, that our examination has not

Imperial Japanese College of Engineering,
Tokio, November 5, 1883.

THE RED SULPHUR OF JAPAN.*

By EDWARD DIVERS, M.D., and TETSUKICHI SHIMIDZU, M.E.

THERE has long been recognised in Japan, as being distinct from ordinary sulphur, a full orange-red variety under the name of *seki-rin-seki* (massive red sulphur). It is allied to the selen-sulphur of the Lipari Islands (Stromeyer), Naples (Phipson), and Hawaii (Dana), but differs from it in composition. The specimen we examined had the following composition:—

Tellurium	0·17
Selenium	0·06
Arsenic	0·01
Molybdenum	trace
Earthy matter	trace
Sulphur, by diff., nearly	99·76
	100·00

When the tellurium sulphur was treated with carbon bisulphide, the arsenic remained as sulphide.

Red or tellurium sulphur appears to be found among all the deposits of volcanic sulphur in Japan. We have obtained it from Iwoshima and Motoyama, Satsuma, and Tateyama, Etchiu. We have also seen some said to have come from Oshima.

The yellow sulphur usually associated with the red sometimes contains traces of tellurium and selenium. The two sulphurs form a striking contrast in colour.

THE BEHAVIOUR OF SILVER CHLORIDE BROMIDE, AND IODIDE WITH BROMINE AND IODINE.

By PAUL JULIUS.

IN order to avoid the use of thallous or palladious oxide in the determination of iodine in presence of chlorine and bromine, in the expectation that, as commonly assumed, silver iodide would be completely converted into bromide, the chloride remaining unchanged, there was passed over silver iodide, and over mixtures of iodide and bromide, vapour of bromine, the substances being kept for ten minutes in a state of fusion.

Through a tube, bent at right angles, there was passed a current of air, previously dried by means of sulphuric acid and calcium chloride, into bromine contained in a small Hofmann's flask.

The air, saturated with bromine vapours, passes thence into a horizontal tube of very infusible gas, containing the substance to be acted upon. At its opposite end this tube is bent down at right angles and somewhat contracted, and passes into a beaker containing potassa or soda. The part of the tube containing the substance is strongly heated by means of a compound Bunsen of four jets. In this manner bromine can be accurately determined in pressure of iodine, as the conversion of silver iodide into bromide is easy and complete.

Silver chloride, previously dried in the air-bath at 120°, was then treated in the same manner with vapours of bromine. After the action had been continued for 1 to 2

* Communicated by the authors. Partly described already at a meeting of the British Association.

hours it was found that all the silver chloride had been converted into bromide.

By further experiments it was proved that chlorine and bromine can be expelled from their silver-compounds by the vapour of iodine, though in case of the chloride this substitution requires from 6 to 10 hours. Hence, any halogen, if applied in excess, is capable of expelling any other halogen from its combination with silver.—*Zeitschrift für Anal. Chemie.*

DETERMINATION OF SULPHUR IN PYRITES.

By G. LUNGE and C. BODEWIG.

G. LUNGE has undertaken experiments to ascertain whether in the aqua-regia used for dissolving pyrites in the moist way there is any advantage in the use of a nitric acid of very great strength. He finds that it is not advisable to take a nitric acid of a specific gravity exceeding 1·42.

Bodewig effects the opening up of pyrites as follows:—

About 0·5 grm. of the sample is introduced into a stoppered flask containing about 30 c.c., about 30 c.c. of water are added, and the necessary quantity of bromine, about 4 c.c. is introduced *at once*. If the bromine is added gradually, sulphuretted hydrogen escapes. The flask is immediately stoppered and shaken for 5 minutes. There is scarcely any heat evolved. The oxidation is complete when all the bromine has passed into solution, and when no pulverulent sulphur creeps up the sides of the flask. The liquid is rinsed into a flat porcelain dish, the greater part of the bromine is allowed to evaporate in the cold; the solution is neutralised in a beaker with ammonia, but not so as to form a permanent precipitate; it is then poured into an excess of hot ammonia in a platinum capsule and digested for 10 to 15 minutes over a small flame. Hereupon it is filtered, the filtrate is slightly acidified with hydrochloric acid, the hot diluted solution is precipitated with barium chloride, and the barium sulphate is purified and weighed in the ordinary manner.

Iron cannot be determined in the same portion, as it is volatilised even in the cold along with the vapours of bromine.—*Zeitschrift für Anal. Chemie.*

ON SOME PHOSPHIDES OF IRIDIUM AND PLATINUM.

By F. W. CLARKE and O. T. JOSLIN.

IN May, 1881, Mr. John Holland, a manufacturer of gold pens in Cincinnati, took out a patent for a process of fusing iridosmine. For pointing gold pens, only selected grains of the native mineral were suitable; and his object was to utilise the quantities of unavailable mineral which accumulated in his establishment. His process, briefly stated, consisted of heating the ore to whiteness, and then throwing in upon it common phosphorus; fusion at once took place, and the excess of phosphorus was afterwards removed by heating the product in contact with lime. The metal thus produced was harder than steel, brilliantly lustrous, insoluble in acids, and available for a great variety of purposes. As the process has already been fully described by Professor W. L. Dudley,* it needs no further technical discussion here. Our work relates to the chemical side of the new iridium industry.

At an early date, samples of the "fused iridium" were placed in our hands for examination, together with some of the original ore from which the melts had been made. The latter was a Californian iridosmine, in hard, brilliant grains, of specific gravity 19·182. Of the fused product the sp. gr. was only 13·768.

* *Sci. Proc. Ohio Mechanics' Institute, Jan., 1882.*

Two portions of the latter were prepared at different times for comparison with the native mineral, and partial analyses were made. In the first portion, phosphorus only was determined, three estimations giving respectively 7·52, 7·58, and 7·74 per cent. This portion contained barely a trace of osmium.

In the iridosmine itself 15·38 per cent of osmium were found; and accordingly the second fused portion was examined with special reference to this element. As far as it was carried ont, the analysis gave the following results:—

Iridium	80·82
Osmium..	6·95
Phosphorus	7·09
Ruthenium and rhodium	7·20
	102·06

No attempt was made to separate the ruthenium and rhodium, nor to trace out the cause of the plus error. The phosphorus agrees reasonably well with the estimations made in the first portion; and the low percentage for osmium, compared with the mere trace in the other lot and the large amount in the ore, shows that this element is more or less eliminated according to the circumstances attending fusing. The "fused iridium" is plainly, as might be expected, a phosphide; and the percentage of phosphorus indicates a compound having the formula Ir_2P. For this formula the percentage of phosphorus should be 7·43, and evidence in its favour will appear farther on. Of course the product is far from pure, containing the phosphides of the other metals of the group; but its general nature is evident. With pure iridium as the starting point, a pure Ir_2P would probably be obtained.

Since it seemed desirable to ascertain how platinum would behave when treated like the iridium, experiments in that direction were undertaken. The metal used was a worn out platinum crucible, carefully cleaned, of which a sample was first analysed. The results were as follows:—

Platinum	97·22
Iridium	2·49
Copper	0·46
Palladium	a trace
	100·17

15·4200 grms. of this material were heated to whiteness in a Hessian crucible, and 20 grms. of stick phosphorus were thrown in. Fusion at once took place, and when the excess of phosphorus had burned off, the mass was allowed to cool. We thus obtained a brilliant silver white, brittle button, weighing 19·4663 grms. As it was porous, we did not determine its specific gravity. If we reckon the iridium in the mass as platinum, and ignore the trifling amount of copper, the increase in weight gives us synthetically the following composition for the product:—

	Found.	Calculated for Pt_8P_5.
Platinum	79·21	79·05
Phosphorus ..	20·79	20·95
	100·00	100·00

These figures are useful only in confirmation of our subsequent analyses.

A portion of the phosphide, coarsely powdered, was next boiled for at least forty hours with aqua regia. At the end of that time a considerable portion was still undissolved, and trial showed it to be quite insoluble in the reagent. The soluble portion amounted to 71·21 per cent of the whole, and the insoluble part to 28·79 per cent. The latter, dissolved by fusion with sodium nitrate and caustic soda and subsequent boiling with aqua regia, was analysed separately, and proved to be a definite phosphide of the formula PtP.

	Found.	Calculated for PtP.
Platinum	86·16	86·28
Phosphorus	14·03	13·72
	100·19	100·00

The soluble fraction, also analysed independently, agreed approximately with the formula PtP_2.

	Found.	Calculated for PtP_2.
Platinum	76·62	75·88
Phosphorus	23·68	24·12
	100·30	100·00

Re-calculating the analyses of the two fractions so as to express the composition of the original phosphide, we get the following results to compare with those obtained by synthesis:—

	Found, Analysis.	Found, Synthesis.	Calculated for Pt_3P_5.
Pt . ..	79·39	79·21	79·05
P	20·87	20·79	20·95
	100·26	100·00	100·00

The data for the foregoing calculations, in weights, are as follows:—Weight of sample, 2·2042 grms. Dissolved, 1·5695 grm.; undissolved, 0·6347 grm. Platinum in the soluble portion, 1·2025 grms.; in the insoluble, 0·5475 grm.; total, 1·7500. Phosphorus in the soluble portion (calculated from weight of $Mg_2P_2O_7$), 0·3717 grm.; in the insoluble, 0·0891 grm.; total, 0·4608 grm. These figures further show that the ratio between the dissolved and insoluble phosphides agrees well with the equation $Pt_3P_5 = PtP + 2PtP_2$:

	Found.	Calculated.
Insoluble PtP . ..	28·79	30·54
Soluble PtP_2	71·21	69·46
	100·00	100·00

The slight discordance here, 1·75 per cent, taken together with the fact that the platinum in the soluble part came out rather too high, shows that a trifling quantity of the PtP was dissolved by the very prolonged action of the aqua regia to which it had been subjected. In other words, the fractionation of the Pt_3P_5 into the two similar phosphides is not quite perfect.

In order to determine whether the complex phosphide Pt_3P_5 could be reduced to metal by long heating, two portions were roasted in a muffle until constant weight was obtained. The losses in weight were 14·08 and 13·78 per cent. respectively. The product of this roasting was malleable, and readily soluble in aqua regia. It contained 7·36 per cent. of phosphorus, which is just the amount required by the formula Pt_2P. Here then we have a fourth phosphide analogous in composition to the fused iridium, and confirmatory of the formula assigned to the latter. The reduction of Pt_3P_5 to Pt_2P should require a loss of 14·66 per cent. In all of these calculations we have taken 195 for the atomic weight of platinum. The trace of copper in the original platinum did not show itself in any of the analyses of the phosphides, and the small amount of iridium present could nowhere affect our results by more than a hundredth of a per cent.

In conclusion, our experiments show the existence of three simple phosphides of platinum, PtP_2, PtP, and Pt_2P, and of a double phosphide, Pt_3P_5. Of these compounds the monophosphide, by virtue of its insolublity in aqua regia, is the most noteworthy. The compound PtP_2 is probably identical with the phosphide described by Schrötter,* who obtained it, as well as analogous phosphides of iridium and palladium, by heating the finely divided metal in phosphorus vapour. As far as we can learn, no other platinic phosphides have ever been regularly analysed. Pelletier* heated platinum with phosphorus and found that 300 grains of the former took up 54 of the lattter; results which approximate roughly to the ratio PtP. Edmund Davy† tried two sets of experiments in the same direction. First, he heated ammonium chloroplatinate with phosphorus, and obtained a black compound of doubtful composition. Afterwards he heated platinum and phosphorus together in a vacuum, and obtained results which, calculated synthetically, agree well with the formula Pt_3P_4. This product was insoluble in strong acids, and at the time (1812) could not be directly analysed. —*American Chemical Journal.*

* *Sitzungsberichte Wien Akad.*, 1849, 301.

* *Ann. de Chimie*, 13, 1792, 101—143.

† *Tilloch's Mag.*, 40, 1812, 27—39. *Schweigg. Journ.*, 10, 382.

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

The progress made during the last twenty years in the preparation and purification of chemical substances has not been followed by a corresponding improvement in the methods which serve to determine some of their physical properties, and this is particularly true of determinations involving the measure of temperature.

The methods used for the graduation of thermometers are often unreliable, the modes of reading them give varying results, and the ordinary tables of corrections contain errors much greater than those which it is intended to correct.

A series of experiments‡ was undertaken with a view to remedying some of these defects by processes which can be easily carried out in a chemical laboratory, and they were extended to an examination of the best methods of manufacturing nearly accurate thermometers, after it was discovered that the principal defects can be remedied by means easily within the reach of a careful instrument-maker. In fact, the methods of preparation and of graduation of thermometers for higher temperatures, which will be proposed, are similar to the processes now in use for pointing the scale between zero and 100°; and it is hoped that they will insure nearly as great accuracy for the temperatures between 100° and 360° as is now obtained with normal thermometers between zero and 100°.

The different sources of error in the kind of thermometric observations that we are considering will be examined in detail.

Mercury Thermometers.—The Calibration.

The standard thermometers made at the observatory at Kew, and those of M. Baudin, of Paris, are calibrated before graduation in order that the stem may be divided into parts of equal capacities, and a subsequent calibration made with the best apparatus shows residual errors of 0·015° to 0·04°, when the scale is divided in tenths of a degree. The process of correction of the errors of calibration and graduation attains an exactitude 0·002°.‖

Thermometers made with extraordinary care, and divided into 500 parts between zero and 100°, or into 360°

‡ Some of the experiments described in this paper have been published in the *Comptes Rendus*, xci., 291, 370, 413, and 574; xciv., 1299; and xcv., 836 and 910. The theoretical considerations of the articles in the *Comptes Rendus* are here omitted, and a greater development is given to the practical directions concerning laboratory operations. The table of corrections for thermometers with a limited scale has been added.

‖ M. Pernet, of the International Bureau of Weights and Measures at Sèvres, has had the kindness to furnish the details regarding the calibration of standard thermometers.

for the complete scale, are found to have a mean error not greater than one-third of a division.

The thermometers ordinarily used in chemical laboratories are far from being equally exact; for instance, 19 French and German thermometers were found to have differences of 0·1° to 0·5° in the length of contiguous sections of 25°. If the tube is regularly conical these differences are cumulative; thus an error of 3·6° at 230° was found in calibrating a thermometer of this kind (the value of the degree between zero and 100° was taken as unity).

Most frequently the variations in the length of a column have sometimes a plus, sometimes a minus sign, but these errors do not usually cancel each other, and it is rare to find ordinary thermometers which do not require at several parts of their scale corrections for errors of calibration amounting to a large fraction of a degree; hence for accurate work the thermometer should be calibrated according to one of the methods described in physical text-books.

It is impossible by the ordinary processes to calibrate the thermometers intended for use at high temperatures, when the tube contains air; but the following method gives a sufficiently exact calibration when the upper reservoir is large enough to contain at least 1-10th of the mercury of the bulb. The bulb is heated until part of the mercury rises into the reservoir and there a globule is separated by a jerk, and by trial a sufficient quantity is detached to make a column of 20° to 30°. The thermometer is allowed to cool in such a manner that this small column follows the mercury in the stem with an interval of 10° to 30°, which space is necessarily filled with air. On account of the air it is impossible by the usual method to change at will the position of the separated column; it follows the main body of the mercury, but it may be fixed without great difficulty at the required points by heating the bulb to temperatures which must remain constant during each observation of the length of the small column. For this purpose a very simple thermostat is employed, consisting of a copper tube about 25 c.m. long with the sides 3 m.m. thick. The bulb of the thermometer is introduced into the tube, placed horizontally, where it is heated by conduction, and the temperature is regulated by placing the lamp under the tube at the requisite distance from the part containing the bulb of the thermometer. In this way it is easy to maintain a sufficiently constant temperature, because small movements of the main body of the mercury do not usually force the detached column to change its position.

The Value of the Degree.

The first accurate researches in thermometry were made in order to find suitable means of determining the two points which fix the value of the degree, and the necessary precautions for determining the freezing- and boiling-points are described in the physical text-books. It is important to use a good barometer, which does not require a notable correction for the capillary depression; and in order that the reduction of the mercury column to zero may be exact, the barometer should be sheltered from rapid changes of temperature. This may be conveniently effected as recommended by Professor Rowland, by wrapping the barometer with its thermometer in several folds of flannel. Instead of the boiling apparatus of Regnault, a glass flask with a long neck of at least 6 c.m. diameter may be substituted without diminishing notably the accuracy of the determination. In all cases the bulb and the entire mercury column must be heated in the steam.

The thermometer may be inserted through a pin-hole pricked in a thin diaphragm of rubber, so that only a few tenths of a degree need be withdrawn from the steam in order to make an observation. Zinc or copper turnings are put in the water.

It is very important to follow an invariable order in observing the points 100° and zero. The 100° point is observed first, and it is indispensable to make the zero determination immediately afterwards. Instead of allowing the thermometer to cool in the vessel used for the boiling-point of determination, it should be taken out quickly, while heated to 100°, and as soon as it has taken nearly the temperature of the air (this requires five to seven minutes), it is plunged into snow which has been for a long time in contact with distilled water. When snow cannot be procured, it is best to substitute ice finely divided by planing it with an ordinary wood plane. This artificial snow may be placed in a cavity at least 5 c.m. in diameter, made in a mass of pounded ice, filling a large vessel, which should be provided with means for draining off the water.*

Even with the best thermometers it is not common to find that exactly 100° of the scale are comprised between the temperature of steam at 760 m.m. pressure (barometer reduced to zero) and the temperature of melting ice. The standard thermometers show divergences of several hundredths of a degree, and thermometers which are made for use in chemical laboratories have errors which are sometimes as high as zero, 0·8° in 100°, which would entail an error of 2·4° at 300°, since all the measures of temperature are divided by the value of the degrees established between 100° and zero.

It is necessary always to follow the method indicated, or at least an invariable matter in determining the value of an interval 100° to zero, since a variation of method may cause this quantity to vary 0·2° to 0·5°.†

Even when an invariable method is employed for the observations, important errors may proceed from another cause, which has hitherto escaped attention: the value of the degree itself usually varies each time that a change of position of the zero-point occurs, and all the constants of the thermometer are changed in different proportions.

During the ordinary usage of a new thermometer at temperatures above 100° a gradual elevation of the zero-point takes place, and the value of the degree changes at the same time. This movement has been followed with seven thermometers made at Paris, of crystal glass containing about 18 per cent of oxide of lead; and during a series of experiments like those common in chemical laboratories, the following elevations of the zero-point and augmentations of the interval 100° to zero were observed simultaneously. The movement was progressive during the whole series of experiments, but only the final variations are given in the table.

* In all exact determinations the snow should cover a considerable part of the scale, and instead of uncovering the zero at the moment of reading its position, it is preferable to bring this point before the smaller aperture of a conical glass tube, which is embedded in the snow, so that the divisions of the thermometer can be read by looking into the larger end. With this arrangement the scale can be conveniently observed with a telescope furnished with a micrometric eyepiece, the lighting is good, and the air of the tube being cooled to zero, the observation is not hindered by the moisture which is usually condensed on the stem of the thermometer in the ordinary method of making zero-point determinations.

† The method here recommended has always been followed by certain experimentalists, and M. Baudin has employed for a long time a similar process for the graduation of his thermometers, but it is only lately that the rule can be considered as established among physicists to take as a point of departure of each measure of temperature the position of the zero-point determined immediately after each observation. The best arguments in favour of this mode of proceeding have been given in the excellent memoir of Dr. Pernet, who has shown what confusion arises when the zero-point is observed before the determination of temperature. In this last case it is necessary to take into consideration the changes which preceding operations have caused in the position of the zero-point, and a minute study of the special qualities of the thermometer is required before the measures taken by different methods can be compared with each other. Dr. Pernet has calculated a series of corrections of this kind for temperature between zero and 100°, and the data will be given further on for making similar calculation in the case of higher temperatures, but only when the zero-point at its maximum of elevation is to be dealt with. The observations of several authors lose all value as true measures of temperature from the absence of details regarding the method which they have employed. It is to be noticed that the graduation of instruments at the Kew Observatory is still based upon the determination of the zero *before* that of the higher temperature.

	2·11	1·24	1·36	2·76	2·38	3·39	2·40°
Increase of the interval 100° to 0°—							
	0·14	0·06	0·05	0·13	0·10	0·19	0·07°

By inducing larger elevations of the zero-point the corresponding changes in the interval 100° to zero can be better studied, because certain irregularities are then only of slight relative importance compared with the larger numbers which have to be considered.

The following series of experiments is well fitted to show the magnitude of these changes, and they were also undertaken particularly to test the point whether the changes produced at moderately high temperature were similar in character to those observed after heating to the highest temperatures to which the thermometer can be conveniently exposed.*

Nos. of thermometers	1	2	3	4	5
Rise of the zero-point	23·0	24·0	26·0	16·6	11·0°
Increase of the interval 100° to 0°—					
	0·9	0·45	0·85	0·50	0·70
Nos. of thermometers	6	7	11	13	15
Rise of the zero-point	15·8	11·7	9·9	12·0	13·7°
Increase of the interval 100° to 0°—					
	0·80	0·50	0·94	0·77	1·30

The thermometers No. 1, 2, 3, 4, 11, 13, and 15 were made of French crystal glass containing about 18 per cent of oxide of lead. The Nos. 5, 6, and 7 were of German soda glass. The seven thermometers were heated eleven days at 355°. The Nos. 11, 13, 15 were heated three years at 166°, 206°, and 266°. It will be seen that similar effects are produced at these relatively lower temperatures and at the highest, and no known fact justifies the opinion of several authors that the phenomena which take place when glass is heated change their character at the different temperatures within the above range. Even at 100° by prolonged heating an augmentation equal to about 0·05° of the interval 100° to zero may be produced, while the position of the zero-point is raised by some tenths of a degree.

Thus after any change in the position of the zero the interval of 100° to zero must be determined anew, and usually a new value for the degree will be found by which all the measures of temperature must be divided. But measures thus corrected will probably not stand in a simple relation with the old ones, and after each considerable change of the position of the zero-point the thermometer should be again compared with the air thermometer throughout the whole length of its scale in order to establish a new series of corrections.

It will be thus seen that this phenomenon has a most disastrous influence upon the precision of thermometric measurements, and it is important to examine into the causes of these movements and to endeavour to find means to suppress them.

Depression of the Zero-point.

Let us consider the case of a thermometer which has been brought by special treatment to what may be called its normal condition at the ordinary temperature This slowly (during several weeks). When such a thermometer is heated successively at a series of different temperatures, each higher than the last, and after each heating cooled immediately in the air and the zero-point observed, a depression of zero is found to correspond with each successive heating at the increasing stages of temperature, and the extent of the depressions rises in a more rapid ratio than the temperatures of the heatings to which they correspond.

It is a well-known fact that the extent of the depression depends upon the manner in which the thermometer is cooled to the ordinary temperature; for example, after heating to 100°, if the thermometer, instead of cooling directly in the air for five to seven minutes, is taken from the heating apparatus and plunged immediately into a series of baths regulated at 60°, 30°, &c., it can be brought to the temperature of melting ice in one or two minutes, and in this case the position of the zero is about 0·05° lower than in the first case. This process of rapid cooling by means of baths is employed by M. Baudin, and consequently the interval of 100° to zero on his thermometers is greater by 0·05° than it is found when determined by the method recommended in this paper.

If the thermometer is cooled as slowly as possible during twenty-four hours after having been heated to 100°, the position of the zero is about 0·15° higher than when it is cooled in the air, and the position of the zero-point is raised about 0·15° still higher when the thermometer is cooled slowly and methodically during a period of several weeks. It is evident that each way of operating would give a different value for the degree.

The method which has been recommended above gives values for the interval 100° to zero which are constant to about one-hundredth of a degree.

The first vertical column of the table contains the numbers designating six thermometers, of which No. 5 is made of soda glass, the others are of crystal containing about 18 per cent of oxide of lead. The remaining columns give the depressions corresponding with the temperatures to which the thermometers have been heated.

It is to be noted that the time required to produce a maximum depression varies with the temperature. At 60° it requires several days, at 100° a few hours, and at the highest temperature from ten to fifteen minutes. The position of the zero at the maximum of depression remains constant on successive heatings at the same temperature.

Table of Zero-point Depressions.

Temperatures	40	60	80	100	160°
No. 1	0·00	0·06	0·19	0·31	0·74°
5	0·04	0·08	0·18	0·29	0·56
13	0·02	0·03	0·17	0·31	0·69
15	0·01	0·05	0·18	0·31	0·75
31	0·02	0·06	0·22	0·37	0·84
32	—	—	—	0·28	0·69

Temperatures	218	260	306	355°
No. 1	1·12	1·33	1·63	2·19°
5	0·76	0·91	1·14	1·51
13	0·87	1·09	1·30	2·15
15	0·97	1·12	1·40	2·05
31	1·15	1·46	1·77	—
32	0·98	1·21	1·56	2·06

This table may be used in the following manner to compare observations made by different methods. Suppose, for instance, that a temperature has been measured by the method which was chiefly used formerly, the zero-point was first taken, and then a series of rising temperatures was observed, as, for example, 100°, 200°, and 300°. The same observations referred to a zero-point determined immediately after each one will give the measures 100·3°, 201·0°, and 301·5°, if the depressions had been the

* Dr. Pernet (*Comptes Rendus*, xci., 471) had stated his opinion that no variation of the interval of 100° to zero is produced when the heating takes place at temperatures not higher than 100°. According to my experiments a variation of the interval must always be looked for when the position of the zero-point changes, and under certain conditions a constant relation may be observed between the amplitudes of these two movements. I have given (*Ibid.*, p. 574) an hypothesis which may serve as a guide to the study of this phenomenon, but I do not propose here to discuss theoretical views, nor to enter into the details of certain experiments which were suggested by them. In this paper it is intended only to discuss the side of the question which is practically more important: namely, the possibility of obviating this source of error. The means by which this result may be effected will be described in full. They consist in a preparatory treatment of the thermometer which serves to make the position of the zero stable within certain narrow limits, and at the same time the value of the degree becomes practically unalterable.

same as the thermometer No. 1 in the table. All these last observations are to be divided by 1·003, which is the value of the degree in this case, and thus the second method would give 100°, 200·4°, and 300·6°, instead of 100°, 200°, and 300°. The table of corrections to reduce the scale of mercury thermometers to that of a gas thermometer is founded on the assumption that the last method of observation has been employed; and consequently when any other method is used, additional corrections like those above must be applied, and the rate of the zero-point depressions under the circumstances of the experiments must be known.

The preceding calculations are only applicable to the cases in which the zero-point has completely returned to its normal position at the commencement of a series of experiments, and also the successive heatings must take place at increasing temperatures. Very often the depression of the zero produced by the preceding experiments still persists at the commencement of a new series, and in that case, instead of observing a depression on heating, a rise of the zero-point is to be noticed, and a knowledge of the laws regulating the elevation of the zero is required to calculate its position in such an experiment. It will be seen that the relations between the measures made by different systems may become extremely complicated, and it is to avoid difficulties of this nature that an invariable method has been recommended, viz., that which takes for the point of departure of each measure the position of the zero determined immediately after each observation of temperature.

(To be continued.)

A RECALCULATION OF THE ATOMIC WEIGHTS.*

By FRANK WIGGLESWORTH CLARKE, S.B.,
Chief Chemist to the U.S. Geological Survey, Washington.

GLUCINUM.

THE atomic weight of glucinum is at present much in doubt; our knowledge of it depending upon the unsettled question whether the oxide is GlO or Gl_2O_3. The formula GlO agrees with Mendelejeff's law, and is advocated by Reynolds,† Lothar Meyer,‡ and Brauner.‖ The symbol Gl_2O_3, on the other hand, is favoured by Nilson and Pettersson,§ and by Humpidge.¶ Humpidge, Meyer, and Brauner offer only theoretical discussions of the subject; Reynolds and Nilson and Pettersson have determined the specific heat of the metal, but give opposed results. In the following calculations the simpler formula will be assumed, not as a finality, but because of its accordance with the system of Mendelejeff.

The data from which we are to calculate the atomic weight of glucinum have been determined by Awdejew, Weeren, Klatzo, Debray, and Nilson and Petterson. Berzelius's** single experiment on the sulphate may be left out of account.

Awdejew,†† whose determination was the earliest of any value, analysed the sulphate. The sulphuric acid was thrown down as barium sulphate; and in the filtrate, from which the excess of barium had been first removed, the glucina was precipitated by ammonia. The figures which Awdejew publishes represent the ratio between SO_3 and GlO, but not absolute weights. As, however, his calculations were made with $SO_3 = 501{\cdot}165$, and Ba probably $= 855{\cdot}29$, we may add a third column showing how much $BaSO_4$ is proportional to 100 parts of GlO:—

SO_3.	GlO.	Ratio.
4457	1406	921·242
4531	1420	927·304
7816	2480	915·903
12880	4065	920·814

Mean 921·316 ± 1·577

The same method was followed by Weeren and by Klatzo, except that Weeren used ammonium sulphide instead of ammonia for the precipitation of the glucina. Weeren* gives the following weights of GlO and $BaSO_4$. The ratio is given in a third column, just as with the figures by Awdejew: –

GlO.	$BaSO_4$.	Ratio.
0·3163 grm.	2·9332 grm.	927·031
0·2872 ,,	2·6377 ,,	918·419
0·2954 ,,	2·7342 ,,	925·592
0·5284 ,,	4·8823 ,,	902·946

Mean 918·497 ± 3·624

Klatzo's† figures are as follows, with the third column added by the writer:—

GlO.	$BaSO_4$.	Ratio.
0·2339 grm.	2·1520 grm.	920·052
0·1910 ,,	1·7556 ,,	919·162
0·2673 ,,	2·4872 ,,	930·490
0·3585 ,,	3·3115 ,,	923·710
0·2800 ,,	2·5842 ,,	922·989

Mean 923·281 ± 1·346

Combining these series into a general mean, we get the subjoined result:—

Awdejew	921·316 ± 1·577	
Weeren	918·497	3·624
Klatzo	923·281	1·346
General mean ..	922·164	0·935

Hence GlO = 25·224 ± 0·269.

Debray‡ analysed a double oxalate of glucinum and ammonium, $Gl(NH_4)_2C_4O_8$. In this the glucina was estimated by calcination, after first converting the salt into nitrate. The following percentages were found:—

11·5
11·2
11·6

Mean 11·433 ± 0·081

The carbon was estimated by an organic combustion I give the weights, and put in a third column the percentages of CO_2 thus obtained:—

Salt.	CO_2.	Per cent CO_2.
0·600 grm.	0·477 grm.	79·500
0·603 ,,	0·478 ,,	79·270
0·600 ,,	0·477 ,,	79·500

Mean 79·423 ± 0·052

Calculating the ratio between CO_2 and GlO, we have for the molecular weight of the latter, GlO = 25·220 ± 0·180. The agreement between this result and the one previously deduced from the sulphate is certainly very striking.

Last of all and best of all we come to the determinations recently published by Nilson and Pettersson.‖ These

* Smithsonian Miscellaneous Collections. "The Constants of Nature."
† *Phil. Mag.*, (5), 3, 38. 1877. CHEMICAL NEWS, xlvii., 273. 18806.
‡ *Ber. der Deutsch. Chem. Gessel.*, 13, 1780. 1880. Also, 11, 57 1879.
‖ *Phil. Mag.*, (5), 11. Jan., 1881.
§ *Berichte*, 11, 381 and 906. 1879. Also, 13, 2035. 1880.
¶ CHEMICAL NEWS, xlii., 261. 1880.
** *Poggend. Annal.*, 8, 1.
†† *Ibid.*, 56, 106. 1842.

* *Pogg. Annal.*, 92, 124. 1854.
† *Zeit. f. Anal. Chem.*, 8, 523. 1869.
‡ *Annales de Chim. et de Physique*, (3), 44, 37. 1855.
‖ *Comptes Rendus*, 91, 168. 1880.

which they write $Gl_2(SO_4)_3 12H_2O$, and which we formulate as $GlSO_4.4H_2O$, yields pure glucina upon strong ignition. The subjoined percentages of glucina were thus obtained :—

14·171
14·169
14·160
14·176

Mean 14·169 ± 0·0023

Hence GlO = 25·048, and Gl = 9·085 ± 0·0055. If O = 16, Gl = 9·106. If SO_3 = 80, then Gl = 9·096.

If the oxide is Gl_2O_3, then the value Gl = 9·085 ± 0·0055 becomes Gl = 13·628 ± 0·0082.

It would be easy enough to combine this value for Gl with those derived from the experiments of the investigators previously cited, but it is hardly worth while. All the other estimations have such high probable errors that they would practically vanish from the general mean. Their influence would hardly extend to the third decimal place, and they may therefore be neglected.

PROCEEDINGS OF SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

THE second of the six lectures on "*Heat in its Mechanical Applications*" was delivered on Thursday evening, the 6th of December, by Mr. WILLIAM ANDERSON, M.Inst.C.E., the subject being "The Generation of Steam, and the Thermodynamic Problems Involved."

The Lecturer commenced by remarking that the source of our fuel supply was derived from the rays of the sun acting upon the earth ages ago. He pointed out that those rays were of complex structure, intimately bound together, and yet capable of being separated and analysed. He remarked that it required over 1000 H.P. to separate 1 ton of carbon from the atmosphere in twelve hours; but that, in consequence of the enormous area of leaf-surface in which the decomposition took place, the action was silent and imperceptible.

As soon as a law of definite chemical combination had been established, chemists began to suspect that the changes of temperature observed in chemical reactions were also of a definite kind, and that they were as much the property of matter as chemical atomic weights. In the last century Lavoisier and Laplace, and after them, down to the present time, Dulong, Despretz, Favre and Silbermann, Andrews, Berthelot, Thomsen, and others, had devoted much time and labour to the experimental determination of the heat of combustion and the laws which governed its development. Messrs. Favre and Silbermann, in particular, between the years 1845 and 1852, had carried out a splendid series of experiments, by means of a calorimeter, which was illustrated by a diagram. The apparatus consisted of a gilt copper receiver, in which the substances tested were burnt by a jet of gas. This receiver was immersed in another vessel containing water, which again was protected by another vessel lined with swans-down. Thermometers of great delicacy were employed to determine the temperatures, and the whole of the apparatus, used for generating the gases and for collecting the products of combustion, was constructed with the utmost ingenuity and skill. Messrs. Favre and Silbermann adopted the plan of ascertaining the weight of the substances consumed, by calculations from the weight of the products of combustion. By this means they were formed the constituents of fuel.

The thermo-chemical laws relating to combustion and decomposition were then stated, and the general formula for calculating the thermic value of any kind of fuel whose analysis was known was explained. It was pointed out that energy existed on the earth in a form which was often unsuitable for the wants of man :—for example, the water flowing down the Alps was competent to furnish the power necessary for boring through those mountains; but it was not in a form which could be used directly. The kinetic energy of the water had first to be transformed into the potential energy of compressed air, and in that form it became available for the miners.

In the same way, the energy of combustion could not be applied directly to the wants of man. It had first to be converted into the form of steam or air at high pressure and temperature, and then, by means of suitable heat-engines, it could be used in the manner with which all were familiar. It was probably to this circumstance that the tardy development of the steam-engine was due, for its history dated back only some two hundred years —a very small proportion of the time during which the human race had existed.

A steam boiler was in reality a species of heat-engine, and its action should be investigated upon the same principles, and consequently the doctrines of Carnot were applied. According to these, the efficiency of a boiler depended entirely upon the range of temperature through which the heated gases acted, and, by means of an illustrationderived from an application of water power, it was demonstrated that the proper way to increase the efficiency of a boiler was to raise the temperature of the furnace to the utmost degree possible, and to lower the temperature of the smoke to the lowest point practicable. Particular instances were then taken in which it was shown that 1 lb. of carbon would be capable of evaporating 14·87 lbs. of water from and at 212°. The case of the prize engine of the Cardiff show of the Royal Agricultural Society in 1872 was described in detail, and it was demonstrated that the maximum amount of work which could be expected from its boiler was equivalent to the evaporation of 13·27 lbs. of water, the actual evaporation having been 11·83 lbs., showing a duty of 89 per cent. In pursuance of the idea of treating a boiler as a heat-engine, an indicator diagram was exhibited and explained, and the laws of Carnot were stated in detail and discussed. The terms of Carnot's formula were then examined separately—first, in relation to the temperature of the furnace, the process of combustion was explained, and it was shown that the temperature of the furnace depended upon the supply of air. A minimum supply would give the highest temperature, but it was found necessary to add an excess in order to make combustion perfect. It was pointed out that the limit to high temperature in a furnace was the imperfection of the material out of which boilers were constructed. It was shown from the fact that steel was capable of being melted in boiler furnaces, that temperatures so high as that were not injurious; but that, when that melting-point of steel was greatly exceeded, the boiler plates began to suffer severely. Next, the temperature of the chimney end of the boiler was examined. It was stated that by the adoption of feed-water heaters and by the use of forced draught, not for the purpose of augmenting the steam-production irrespective of economy, but with a view to promoting economy, that the temperature of the smoke could be lowered to about 100° above that of the feed-water. The loss of 11 per cent in the Cardiff boiler was then looked into, from which it appeared that it arose partly from radiation and convection form the body of the boiler, partly from imperfect combustion, which always prevailed more or less, and partly from losses incidental to the transfer of heat from substances

less dense to others more dense, and *vice versa*. It was stated that this loss was common to all energy propagated by undulatory motion, such as light, heat, or sound. The law of conduction through plates was then explained, and it was pointed out that even joints in a bar of uniform material interposed a certain amount of resistance, and the fact was illustrated by an experiment. The loss was much greater when there was a joint between dissimilar materials, such as between the gases of the furnace and the boiler plate, and between the boiler plate and the water. At first sight it would appear a matter of common sense that a boiler which contained its own furnace must be a better generator than one with an external furnace formed of brick-work; but brick-work was an extremely bad conductor of heat, while it was a very good radiator, absorbing heat from the gases and returning them by radiation to the boiler surfaces. This action was strongly pronounced in the case of the reverberatory furnace, and in the brick arches now commonly introduced into the fire-boxes of locomotives.

The gases forming the products of combustion were very bad absorbers, and very bad radiators of heat. Pure dry air and nitrogen were absolutely incapable of absorbing or radiating heat. They were not in the least affected by the passage through them of the most intense heat-rays. Carbonic acid was a somewhat better radiator, while the vapour of water was a good absorber, and therefore a good radiator. It was then demonstrated that the products of combustion consisted mainly of air and nitrogen, and consequently, taken as a whole, the products of combustion were bad radiators. Little or no economical advantage was derived from making the combustion in the boiler perfect, because the colder luminous flame was a good radiator, on account of the white-hot particles of carbon it contained, while the hotter and non-luminous flame was a bad radiator, and carried a great deal of the heat into the chimney. This circumstance was illustrated by an experiment, by which it was proved that an intensely hot non-luminous Bunsen flame had very little more effect upon an air thermometer than a smoky luminous flame burning the same quantity of gas, but that the moment a spiral wire was hung in the Bunsen flame, it commenced to glow, and the radiation from the wire immediately had a powerful effect upon the thermometer. It was probably owing to this circumstance that the backwardness of the owners of steam-boilers to prevent smoke was to be attributed. Had considerable advantage been obtained by the suppression of smoke, Acts of Parliament would not have been necessary for the purpose.

A different class of boiler was required for consuming flaming fuel, as contrasted with such fuel as anthracite and coke, burning with very little flame. In the latter case, tubular boilers were preferable; but unless the combustion was perfect before the gases reached the small tubes, the gases cooled down so considerably that the flame was frequently extinguished. This fact was illustrated by an experiment, which showed that when pieces of ½-inch gas-pipe of various lengths were placed over an ordinary gas-flame, the shorter tubes allowed the flame to pass through, while the longer ones extinguished it, and the gas could be re-lighted at their upper ends. Water, being completely adiathermanous, and a very bad conductor, could not be heated by direct radiation or conduction. The process of heating by convection was explained in detail, and a comparison was instituted between the heat transmitted from the hot gases in the furnace of a boiler to the water, with the reverse effect of warming by the transfer of heat from hot water pipes to the air of a room. The two being reverse operations, agreed very closely together in accordance with the theory of exchanges. The proper heating-surface to be allowed in a boiler to effect a given amount of evaporation was then dwelt upon. The mode of calculating the sectional area of tubes and flues was given, the heat of the chimneys and their area was considered, and finally the thermodynamic theories relating to the formation of steam were investigated. It was stated that, of necessity, the molecules of steam which became emancipated from the water through the energy of heat, carried with them particles of water, and that these particles constituted priming, the amount of which depended upon the velocity with which the steam escaped from the water. A Table was exhibited of a large variety of boilers ranged in order of the velocity and disengagement of steam from the water-surface; and from this it appeared that those in which the velocity was highest were also those most subject to priming. The doctrine of the viscosity of liquids and gases was next dealt with, and applied to account for the manner in which particles of water and of very minute solid impurities were carried over from the water of the boiler into the steam. The same theory was adduced to show that from the slowness with which smoke fell in the atmosphere, it must be composed of exceedingly small particles, and that they were not very numerous compared with the volume of the gases with which they were associated. It further went to show how it was that complete combustion did not produce any marked economy, because the absence of the white-hot particles of carbon from the gases caused a loss of radiating power. It was thought that no great improvement was to be expected in the economy of boilers, for the limit had been already almost reached.

The honour of having first pointed out the true principles on which the duty of boilers should be estimated, namely, by comparing the work actually done with the potential energy of the fuel used, was due to the late Professor Rankine.

The Lecturer concluded by a tribute of respect and admiration to the late Sir William Siemens, whose name was closely associated with the subject of his lecture. At the time of his death, Sir William Siemens was engaged in perfecting a pyrometer, intended to indicate accurately temperatures above those of melting steel. In addition therefore to the many causes of regret for his lamented decease, was to be added this, that the production of a trustworthy pyrometer would be indefinitely postponed. The impulse which Sir William Siemens had given to the study and elucidation of thermodynamics would not cease with his life, but this and succeeding generations would long profit by his example and his labours.

CORRESPONDENCE.

ATOMICITY OF ELEMENTS AND COMPOUNDS.

To the Editor of the Chemical News.

Sir,—It seems to be a favourite hypothesis with chemists by way of accounting for water of crystallisation, the existence of hydrates, of double salts, of such compounds as Friedel's chlorhydrate of methyl oxide, the combination of phosphorus pentachloride with iodine chloride, of bromine and iodine with phosphorus pentachloride, and all such compounds, to suppose that there exists either in the atoms themselves composing the molecules some residue of unsatisfied atomicity, or that some of the elements themselves possess a variable atomicity. Thus platinum, which is usually quadrivalent in platinic salts, is supposed to become sexavalent in the double chloride of platinum and potassium; in other cases, chlorine to become bivalent, and bromine and iodine to change their atomicities. It seems difficult to suppose that monatomic bodies like these last, and bodies of which the valency seems so well determined, should be so liable to change their atomicity on frequent occasions. Is there any valid reason why we should not suppose that the entire molecules, acting as entities or compound atoms, come to possess an atomicity of their own, attracting one another, or the atoms of water as the case may be, or that water itself may possess an atomicity of its own?

If this be not the case it seems difficult to otherwise

other salts, develop great heat in combining with water. So also does hydrated sulphuric acid.

Such strong combinations as these seem hardly accounted for by any residual atomicity of the elements composing the compounds, and some other reason is required.

I cannot possibly understand why recur to a hypothesis which upsets the whole atomic theory which we have so carefully and so laboriously built up while any other solution is open.—I am, &c.,

F. Maxwell Lyte, F.C.S., F.I.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Quesneville.
November, 1883.

Properties, Preparation, and Composition of the Nitrogen Iodides.—A. Guyard.—This voluminous paper is provided with several illustrations, and treats in the first place of the photometric properties of nitrogen iodide in the moist state or when under water.

Manufacture of Japanese Lacquer.—From the *Journal of the Society of Arts.*

Theoretic Researches on Alizarin-red Dyeing.—G. Saget.—The author has succeeded in obtaining calcium and aluminium alizarates, and proving their definite character. Both these salts are decomposed by dilute acids with liberation of alizarin. In pure water alizarin does not dye with aluminous mordants. Under a pressure of two atmospheres it forms a pale violet-red lake, but the alumina is not saturated. In order to effect dyeing, a salt of calcium must be present, preferably the carbonate. The first action of the alizarin is to form with the calcium carbonate, calcium alizarate, which undergoes double decomposition with the alumina fixed upon the cloth. Calcium carbonate is re-constituted and again enters into reaction. The lake is not a pure aluminium alizarate, but a double calcium aluminium alizarate. By dyeing, we obtain a garnet lake, which is not the true alizarin red lake, but is soiled by impurities from the wares employed and by an excess of calcium alizarate. It is purified by the clearing process, which consists of oiling, steaming, and soaping.

New Experiments on the Determination and the Physiological Production of Urea.—L. Hugounenq.—The author does not give his analytical process. He finds that in the normal condition, and under a normal nutrition, the ureic coefficient varies within certain limits directly as the quantity of nitrogen ingested. In a state of physiological inanition the figure of ureic excretion does not fall below 5 grms. of nitrogen. This minimum number may be called the coefficient of auto-combustion, and expresses the quantity of excrementitious nitrogen derived from the combustion of the organic tissues alone.

A New Method of Determining Nitrogen in Organic Matter.—J. Kjeldahl.—Already inserted.

Influence of Silica on the Determination of Phosphoric Acid by Means of Molybdic Acid.—A. Bertrand.—The author maintains that the previous elimination of silica is unnecessary. He differs also from Bolley and Kopp, who state that nitric acid does not completely dissolve mineral phosphates. He finds that nitric and hydrochloric acids are equally good solvents.

more costly.

Journal de Pharmacie et de Chemie.
Tome viii., November, 1883.

Experimental Study on the Microbicide Action of Copper Sulphate.—M. Rochefontaine.—The spores of the mucedinæ can develop in solutions of copper sulphate containing 1 per cent. The vibriones of putrefaction swarm in cupric solutions at 1-10th per cent. The proportion of copper necessary to arrest the development of vibriones is at least four times greater than that which proves fatal to guinea-pigs, and ten times greater than that sufficient to destroy dogs. Experimental bacteriæmia can be equally produced in animals whether they have undergone subcutaneous injections of copper sulphate or not. Bacteria can be developed in the blood of animals which have died from the effects of copper sulphate, whether taken internally or introduced subcutaneously.

Influence of Salts of Lead on the Detection of Phosphorus by the Method of Mitscherlich.—H. Beckurts.—In Otto's treatise on poisons it is stated, on the authority of Schwanert, that the presence of lead salts hinders phosphorescence in Mitscherlich's apparatus. Researches undertaken with bread, meat, &c., mixed with the ends of phosphorus matches and various salts of lead, prove that these salts are no obstacle to the luminosity of phosphorus, and that phosphorous acid is easily detected in the apparatus.

Archives Neerlandaises des Sciences Exactes et Naturelles,
Tome xviii., Part 3.

The Equations of Motion of the Electro-magnetic Field.—C. H. C. Grinwis.—A mathematical paper, for which we must refer to the original.

Rhizopogonic Acid.—A. C. Oudemans, Jr.—This acid was first obtained by M. F. A. Hartsen from *Rhizopogon rubescens*, a fungus found in the South of France, and has been more closely examined by the author. Its formula seems to be $C_{20}H_{26}O_3$. In water it is completely insoluble. Ether, chloroform, carbon disulphide and ligroine dissolve it easily. It forms long, splendid crystalline needles of a blood-red whilst moist, but taking a more orange tint when dry, somewhat like sublimed alizarin, but without the same lustre. At 127° it melts to a brownish-red liquid and is decomposed at temperatures above 300°. It is a feeble acid, and decomposes the alkaline carbonates, but the salts formed are unstable, being decomposed if boiled with excess of water or alcohol.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome x., October, 1883.

Report presented by M. Aimé Girard on M. Paul Horsin Déon's Treatise on the Manufacture of Sugar.—Not capable of useful abstraction.

Justus Liebig's Annalen der Chemie,
Vol. 221, Part 3.

Molecular Volumes of Liquid Substances.—R. Schiff.—The author gives the following as the more important results of this voluminous paper:—The specific volumes of carbon and oxygen are variable, varying with the variation of the atomic catenation. The presence of a so-called double bond increases the molecular volume. For each of these bonds between carbon and carbon the increment amounts to 4 unities. The benzol nucleus can contain no double, but merely single bonds.

MISCELLANEOUS.

Royal Institution of Great Britain.—Probable arrangements for the Friday Evening Meetings before Easter, 1884, to which Members and their friends only are admitted :—

Jan. 18.—Prof. Tyndall, D.C.L., F.R.S., "Rainbows."
Jan. 25.—The Rev. Prof. T. G. Bonney, M.A., F.R.S., "The Building of the Alps."
Feb. 1.—Prof. F. Max Müller, "Râjah Râmmohun Roy, the Religious Reformer of India (died at Bristol, 1883)."
Feb. 8.—George J. Romanes, M.A., LL.D., F.R.S., "The Darwinian Theory of Instinct."
Feb. 15.—Prof. T. E. Thorpe, F.R.S., "The Chemical Work of Wöhler."
Feb. 22.—Sir Frederick Bramwell, F.R.S., "London (below bridge) North and South Communication."
Feb. 29.—Prof. D. E. Hughes, F.R.S., "Theory of Magnetism" illustrated by Experiments.
March 7.—C. Vernon Boys, A.R.S.M.
March 14.—J. N. Langley, F.R.S.—The Physiological Aspect of Mesmerism."
March 21.—Mr. Walter Besant, "The Art of Fiction."
March 28.—Prof. Osborne Reynolds, M.A., F.R.S., "The Two Manners of Motion of Water shown by Experiments."
April 4.

MEETINGS FOR THE WEEK

THURSDAY, 27th.—London Institution, 7.
—— Royal Institution, 3 p.m. "Alchemy," by Prof. Dewar.
FRIDAY, 28th.—Queket', 8.
SATURDAY, 29th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.

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THE PATENTS DESIGNS AND TRADE MARKS ACT 1883.

WITH INTRODUCTION, NOTES, AND INDEX TO THE SECTIONS RELATING TO PATENTS.

BY

JAMES JOHNSON,
OF THE MIDDLE TEMPLE, BARRISTER-AT-LAW.

and

J. HENRY JOHNSON,
ASSOC. INST. C.E.
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THE CHEMICAL NEWS.

VOL. XLVIII. No. 1257.

REDUCTION OF METALLIC SOLUTIONS BY MEANS OF GASES, &c.*

By Dr. G. GORE, F.R.S.

THE following experiments were made chiefly for the purpose of ascertaining the effect of various gases and liquids in reducing metals from their solutions.

Experiment 1. A mixture of dry and pure carbonic oxide and carbonic anhydride gases, passed in a stream slowly through various liquids, had the following effects:—A solution of bichloride of palladium was rapidly decolourised, and all its metal precipitated as a black powder. One of tetrachloride of platinum was slowly decomposed, and yielded a small amount of yellow precipitate in two or three days. With one of chloride of iridium and potassium, the whole of the iridium was precipitated after a long time. Solutions of argentic nitrate, mercuric chloride, plumbic nitrate, ferric chloride, manganous chloride, permanganate of potassium, chromic acid, and a green solution of vanadium, showed no signs of reduction. A solution of green vitriol with which an excess of pure sodic hydrate had been mixed did not become oxidised.

2. The same mixture of gases was passed through a lead vessel containing milk of lime. It imparted to the surface of the vessel a film of red oxide of lead, probably by reduction of carbonate of lead by the carbonic oxide.

3. By passing carbonic oxide during two days through a solution of potassic cyanide with a rod of bright magnesium half immersed in it, the liquid became brown, and the metal was coated with a blackish film in the liquid. Magnesium alone in a similar solution did not turn the liquid brown in three days.

4. A dilute solution of bichloride of palladium exposed to a mixture of hydrogen and carbonic anhydride (or to pure hydrogen alone), had the whole of its palladium gradually precipitated in the metallic state in a period of twenty-four hours.

5. An atmosphere of coal-gas was maintained in contact with the following dilute liquids, each of which had a vertical platinum wire partly immersed in it. The liquids were in open bottles in a dark place. Dilute solution of palladic chloride:—Rapid reduction to the state of metal as a film upon the surface of the liquid in four hours; the solution became colourless in a few days; some of the metal was also precipitated as a black powder, and some as an adhering bulky lump on the end of the wire. With dilute terchloride of gold, in the course of a few days, beautitul films of metal, bright, and of exceeding thinness, were produced upon the surface of the solution. Much gold was also deposited upon the bottom end of the wire. The films formed successively and sank. The liquid was not wholly decomposed in three weeks. Solid crystals of auric-chloride were gradually reduced to metal. Solution of platinic chloride was only slightly decomposed in ten weeks. With a solution of argentic nitrate:—Signs of decomposition occurred in a few hours. In fourteen days a deposit of metal had formed upon the sides of the glass bottle; but the whole of the silver was not deposited in seven weeks. With cupric sulphate, no reduction, and but little action upon a strip of copper (instead of platinum) took place in ten weeks. With a platinum wire in a dilute solution of ferric sulphate, no visible effect occurred in eighteen days.

6. The gaseous products (containing acetylene) of a blown down and smoky flame of a Bunsen burner were collected over water and passed through various liquids. They rapidly decomposed a solution of palladic chloride, and less quickly one of terchloride of gold; a solution of platinic chloride was slightly affected, and one of chloride of iridium and potassium remained unaltered.

7. A solution of palladic chloride in contact with amylene showed signs of decomposition even in a few minutes, and was abundantly decomposed in two days; it was also reduced to metal by American petroleum, benzine, and Persian naphtha less speedily; slowly by toluol, xylol, "petroleum ether," and mesitylene; with the ether, a bright metallic layer was formed between the two liquids. It was reduced very slowly by Rangoon lamp-oil, and by "sherwoodole," and not at all by ozokerite, solid paraffin, or napthalene.

8. An aqueous solution of auric chloride, especially a strong one, was rapidly decomposed by carbolic acid, with liberation of the metal; also, but more slowly, by mineral naptha, Persian rock-oil, benzole, C_2Cl_2, and Rangoon machinery oil, with similar effects; slowly by "petroleum ether," and very slowly by toluol, xylol, and mesitylene; paraffin, anthracene, napthalene, C_2Cl_4, Rangoon petroleum butter, C_2Cl_6, benzoic acid, soft elaterite, hard elaterite, CCl_4. Sherwoodole, chrysene, or ozokerite had but little or no decomposing effect. The solution of chloride of gold was less rapidly decomposed than one of palladic chloride, especially by mineral naphtha and benzole. Amylene produced a most beautiful film of gold upon the surface of the auric solution.

9. Platinum was separated from a solution of platinic chloride by benzole, American rock-oil, Persian naphtha, and other similar liquids.

10. An aqueous solution of chloride of iridium and potassium was decolourised in two days by contact with benzole. With amylene no effect was visible in that time.

11. Amylene, in contact with an aqueous solution of mercuric chloride during one week, slowly produced a white precipitate. By agitating amylene with a solution of permanganate of potassium, the latter was instantly decolourised; the residue was entirely soluble in hydrochloric acid, but with one of cupric chloride in aqueous ammonia, or of ferric chloride, chromic acid, chromate, or acid chromate of potassium, no visible effect occurred.

12. Benzole, agitated with a solution of potassic permanganate, rapidly decolourised it, but had no effect upon one of perchloride of iron. Benzole darkened the colour of solutions of palladium, gold, and platinum.

13. With a solution of telluric chloride, or one of terchloride of antimony, amylene, benzole, and Persian naphtha produced only a slight effect in fourteen days. With Persian naphtha and a solution of chloride of bismuth, a slight change occurred in eleven days.

The films of gold and palladium formed upon the surface of a liquid by contact of a gas, or between two liquids at their dividing line by a non-miscible solution, might prove of service in some physical experiments.

It is worthy of consideration whether the reduction of metals to the native state in the interior of the earth may not in some cases have been effected by contact of their solutions with liquid or gaseous hydrocarbons derived from coal and other mineral substances of organic origin.

* Read before the Birmingham Philosophical Society, December 13th, 1883.

Reactions of the Aromatic Chloro-carbons.—A. Weber and C. Söllscher.—The aromatic chloro-carbons, especially perchlorised benzol and diphenyl, are by no means so indifferent in alcoholic solutions of alkalies as is commonly supposed. Perchlor-diphenyl, if kept for some hours at 180° to 200° in alcoholic soda, yields products which are readily soluble in alkalies and are re-precipitated by acids as white, caseous flocks.—*Berichte der Deutschen Chemischen Gesellschaft zu Berlin.*

SEPARATION OF BISMUTH AND COPPER.

By Dr. JULIUS LÖWE.

Some time ago the author communicated to this journal the observation that the oxides of bismuth and copper in solution are precipitated by soda or potassa in presence of glycerin, but are completely re-dissolved by an excess of the precipitant. In this alkaline solution both show a similar behaviour with a solution of glucose, being both reduced at a boiling heat, the copper to red cuprous oxide and the bismuth to grey, finely-divided metal. They differ, however, in their behaviour with glucose, in the cold or at a gentle heat; copper in the course of several hours being completely deposited in the form of red cuprous oxide, whilst the alkaline solution of bismuth undergoes no change. Not until after the solution has stood for some days are small quantities of the bismuth deposited in the metallic state. This reaction may be very conveniently used for separating copper and bismuth as well quantitatively as qualitatively from a mixed solution in nitric acid, in all cases when the bismuth predominates.

For this purpose the nitric solution, not too acid and not too concentrated, is placed in a beaker and mixed with a measured volume of soda-lye until the oxides are precipitated and the supernatant liquid shows an alkaline reaction. During this process the temperature must not be allowed to rise. Then double the volume of the lye consumed is added, and pure, syrupy glycerin is then stirred in until the oxides are completely re-dissolved and the liquid becomes clear. This deep blue solution is mixed with a solution of pure glucose (1 part in 6 to 8 parts of water) in such a proportion that the sugar may amount to three to four times the joint weight of the metals. The beaker is then covered with a well-fitting glass plate, and the liquid is let stand 8 to 10 hours in a cool, dark place. The blue colour is then found to have given place to a deep yellow, whilst the copper is deposited at the bottom of the beaker as a bright red oxide, mostly not adhering to the glass. The yellow liquid is poured off, without stirring, upon a filter which has been dried at 100° and weighed. The cuprous oxide is washed by decantation, first with water, containing a little glycerin, and soda-lye, collected upon the filter, and then well washed with distilled water. After the last portions of washing-water, which should be free from alkaline reaction, are run off, the filter is cautiously lifted out of the funnel, laid upon good absorbent paper, and then dried at 100° in the air-bath. The increase of weight of the filter gives the quantity of red oxide, 100 parts of which represent 88·8 parts of metallic copper.

Where greater accuracy is required the red oxide obtained after weighing is converted into oxide in the ordinary manner after incineration of the filter, &c., and the copper is determined in its solution by any ordinary method.

The alkaline filtrate, containing all the bismuth, is placed in a sound, well-glazed porcelain capsule, heated to a boil over a free flame, stirring gently, kept at this temperature for a short time, removed from the source of heat, and the brownish liquid is allowed to cool and settle. It is then filtered through a filter which has been dried at 100° and weighed. The metallic bismuth is first washed by decantation with water containing soda, collected on the filter, and further washed first with cold and then with hot water. The drying is effected as in the case of the cuprous oxide, and the increase of weight of the filter gives the quantity of the bismuth.

The glaze of the porcelain capsule must be of the best quality, lest any particles of metal may be deposited upon it and prove hard to remove. The metal is also reduced in the water-bath, but less rapidly than over the naked flame.

The finely divided metallic bismuth must be washed the fine metallic particles may otherwise easily pass through.

If the weight of the bismuth is decidedly greater than that of the copper this process yields very satisfactory results. The author purposes to make further investigations on the converse case.—*Zeitschrift Analyt. Chemie.*

DETECTION OF CHLORINE, BROMINE, AND IODINE.

By FRANCIS JONES, F.R.S.E.

In the December number of the *Journal of the Chemical Society* some experiments are described on a process due to Vortmann, for the detection of chlorine, bromine, and iodine in mixtures. I have lately introduced a method (suggested to me by the process employed on the large scale for the manufacture of iodine and bromine) which is based on the same principle, but carried out in a simpler and more convenient manner, and which serves extremely well for the detection of the three elements. The process is carried on in the following way:—Place a *small* quantity of the mixture to be tested in a good sized test-tube, add a few pieces of manganese dioxide and then a little water. Add now *one* drop only of dilute sulphuric acid (one part acid to ten of water); a brown tinge indicates the presence of iodine. Boil the mixture, and confirm the presence of iodine by the violet vapours in the upper part of the tube. Continue the boiling till these vapours cease to appear, then add another drop of sulphuric acid and boil again till they cease. If necessary repeat this addition of acid and boiling until violet vapours have entirely ceased. Now add about two cubic centimetres of the dilute acid and boil again: brown vapours indicate bromine. Continue the boiling until the vapours no longer smell of bromine, then add one cubic centimetre dilute acid and boil again. When the vapours no longer smell of bromine allow the residue to cool *completely*; add an equal bulk of *strong* sulphuric acid and warm; a green gas bleaching a piece of moist red blotting-paper at the mouth of the tube indicates chlorine.

Occasionally some bromine comes off on addition of the strong acid, but if so it is soon got rid of, and is succeeded by the chlorine, which is chiefly evolved on warming the mixture. As, moreover, moist red blotting-paper is far more quickly acted on by chlorine than by bromine, there can be no difficulty in distinguishing between the two elements.

I have compared the results obtained by my students when using this and other methods, and find they are far more successful with the new method.

SEPARATION OF STRONTIUM AND CALCIUM.

By M. D. SIDERSKY.

The method of separating these two metals is based on the following reaction:—When a mixture of oxalate and sulphate of ammonium is added to a salt of strontium containing calcium, the precipitate contains all the strontium in the form of sulphate, whilst the whole of the calcium is found in the form of oxalate. These two salts are then easily separated by dilute hydrochloric acid. By previously adding a little hydrochloric acid to the solution the precipitation of oxalate of calcium is prevented.

The method of working is as follows:—Suppose a strontianite is to be analysed. The powdered mineral is attacked at the boiling-point by the smallest possible quantity of strong hydrochloric acid, and the solution

supersaturated with ammonia, which precipitates iron, alumina, and silica. After filtration the liquid is concentrated by evaporation, acidulated with hydrochloric acid, and precipitated by a solution containing, per litre, 200 grms. of sulphate and 30 grms. of oxalate of ammonium. This precipitates sulphate of strontium, which is collected on a filter and weighed after washing The filtrate, supersaturated with ammonia, yields a precipitate of oxalate of calcium.

The analytical results which the author quotes in support of this method are satisfactory.—*Zeitschrift für Analytische Chemie.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending November 30th, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, December 6th, 1883.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 182 samples of water, the whole, with the exception of three samples which were recorded as "very slightly turbid," were clear, bright, and well filtered.

The supply throughout the month has continued to be of excellent quality; and in particular, the proportions of organic carbon, and consequently of organic matter, though in excess of the very small amounts recorded for several months past, have been low for the season of the year.

It will be observed that despite important differences of interpretation, the actual results obtained by ourselves are usually in fair accordance with those reported to the Registrar-General. Thus the mean amount of organic carbon in 100,000 parts of the water furnished during the six months preceding October, by the five Companies taking their supply exclusively from the Thames was, according to our experiments, 0·116 part, and according to the reports made by the Registrar-General, 0·123 part, a difference of 0·007 part only. As regards, however, the discrepancy noticeable in the two sets of results for October, we would call attention to the circumstance that our report was based on an examination of nineteen specimens of Thames-derived water, each collected on a different day; and that our determinations of organic matter by means of the combustion process were checked by the results of a wholly different process of examination. On the other hand, the report made to the Registrar-General on the character of the Thames "waters supplied to the Metropolis *during* the month of October," was based on an examination of five specimens only, all collected on the same one day of the month. Further, the results, furnished by the combustion process applied to these five specimens, were wholly unchecked by any different method of examination.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON CADMIUM IODIDE.

By F. W. CLARKE and E. A. KEBLER.

Of late years the suggestion has repeatedly been made, by various chemists, that the definite series of related chemical elements may be analogous in character to series of compounds such as the hydrocarbons. For example, fluorine, chlorine, bromine, and iodine form one such series; the nitrogen group, from nitrogen to bismuth, forms another, &c. There have been many efforts to trace relationships between the atomic weights in these and other similar series, and so to get evidence in favour of the foregoing hypothesis; but except in the establishment of the periodic law, all such attempts seem to have ended fruitlessly.

But notwithstanding the failure to discover definite numerical relations between the elements, the evolutionary speculation is suggestive. If the series of elements are developed progressively, like series of compounds, there should be various points of comparison; and one line of thought is as follows. In any series of compounds the possibility of isomerism increases as we ascend; and therefore, by analogy, we should expect to find a similar state of affairs among the so-called elements. The derivatives of the highest member of a series should be more numerous and complex than those of lower members, and cases of allotropy or isomerism ought also to be more frequent. Whether this is so or not in all known instances we do not attempt to say; our experiments bear upon a single point, and that may be stated briefly.

It is a well-known fact that allotropy is common among the metallic iodides, and much more so than among the corresponding compounds of chlorine and bromine. For example, the scarlet and yellow modifications of mercuric iodide, and the three varieties of antimony iodide may be cited. We have been engaged in the study of several other iodides, especially that of cadmium, and in this case we are now prepared to announce the existence of two distinct modifications. So far, then, our results lend countenance to the speculative idea which we began by quoting, even though much weightier evidence would be needed to put it upon the basis of a clear and definite theory. The speculation, however, instigated our experiments, and in their success its utility as a means of stimulating research is justified.

Up to the present time but two determinations of the specific gravity of cadmium iodide have been published. First, by Bödeker, who found it to be 4·576 at 10°; and, second, by Fullerton, whose mean result was 5·9798. The latter determination was made some years ago in this laboratory, and is undoubtedly too high; but the discordance between the two is so great that it could hardly be ascribed to error. Accordingly, we prepared cadmium iodide by a variety of methods, and obtained the following determinations of specific gravity. All weighings were made in benzene, and the results are referred to water at 4° as unity. Our mean figures may be stated first, and the details given later.

A. Cadmium and iodine, in equivalent quantities, were heated together in a sealed tube from which the air had been exhausted. The product was white, and contained

water. The crystals obtained by evaporation were carefully identified as CdI_2. Sp. gr. 5·622.

C. A very fine sample of iodide prepared by Schuchardt, of Goerlitz, was examined. Its mode of preparation, as stated in a letter from the maker, consisted in dissolving together equivalent quantities of cadmium sulphate and potassium iodide, evaporating to dryness, extracting with alcohol, and crystallising. Sp. gr. 5·660.

D. Preparations A and B were mixed and re-crystallised from alcohol. The sp. gr., as determined by Mr. E. Twitchell, was 5·701.

So far, at least, the variations in our results were not startling. Our next series came out differently.

E. Cadmium carbonate was dissolved in hydriodic acid. The solution, discoloured by free iodine, was rendered nearly colourless by cadmium clippings, and crystallised. Sp. gr. 4·612. A second series of determinations gave 4·596. Both figures agree well with Bödeker. The salt was analysed, with results as follows :—

	Found.	Calculated for CdI_2.
Cadmium	30·40	30·60
Iodine	69·33	69·40
	99·73	100·00

F. To verify these results, if possible, another lot of iodide was prepared with carbonate and acid, but the solution was not decolourised by metal. Sp. gr. 5·729. The sample on analysis yielded 30·56 per cent of cadmium.

G. Another solution was prepared as under F, and divided into two parts. One was allowed to evaporate spontaneously at a low temperature. Sp. gr. of product 5·610.

H. The second part of solution G was boiled down rapidly. Sp. gr. of iodide 5·675.

I. Metallic cadmium was dissolved in hydriodic acid. The solution yielded a pure iodide of sp. gr. 4·688, as determined by Mr. Twitchell. This preparation dried at 50° became silver-grey, and its sp. gr. rose to 5·141. Again heated to 50°, the sp. gr. rose to 5·536. A third heating brought it up to 5·545. Accompanying this change there was a little decomposition, which resulted in the formation of a trifling amount of insoluble material.

The foregoing results all point pretty definitely to the existence of two allotropic varieties of cadmium iodide, differing in specific gravity by about a unit. The higher density represents a union of cadmium and iodine with little or no change of volume, while the lower corresponds to a noteworthy expansion and consequent instability. The higher or normal salt, which we may call α-cadmium iodide, is white, and undergoes no perceptible change when heated to any temperature below 250°. The lower, or β-salt, is brownish, and loses weight even at 40°. One sample lost 5·50 per cent at 50°, an alteration which is undoubtedly due to the formation of an oxide or oxy-iodide with liberation of iodine. The increase in specific gravity upon heating may be partly due to the same change, but is mainly ascribable to a transformation of the β into the α modification. The conditions governing the formation of the new salt are obscure and need further study. In our experiments we obtained it only twice, and in each case cadmium was acted upon by hydriodic acid. In the first instance, however, this action was only incidental to the decolourisation of a solution of iodide otherwise prepared, and was necessarily very trifling. In both cases, however, cadmium iodide was exposed to the action of nascent hydrogen, and it is probable the latter had something to do with the production of the β compound. This suggestion we offer merely as a clue for use in further study, without any speculations as to just how the reactions proceeded.

I. *The Normal* CdI_2.

A.	B.	C.	D.
5·539 20·4°	5·622 15·2°	5·697 17·5°	5·716 14·8°
5·530 20·1	5·618 15·2	5·704 18·0	5·714 15·3
5·530 20·1	5·638 15·2	5·630 18·2	5·696 15·5
5·574 20·2	5·629 15·4	5·650 18·1	5·696 15·8
5·543 19·9	5·630 15·6	5·642 18·2	5·685 15·9
5·543 19·9	5·621 16·1	5·626 18·2	
5·523 19·8	5·610 16·6	5·672 18·2	
5·564 20·1	5·611 16·6		
5·543	5·622	5·660	5·701

F.	G.	H.
5·750 10·5°	5·580 17 6°	5 682 15·0°
5·740 10·5	5·610 17·4	5·654 15·2
5·715 10·6	5·660 17·7	5·683 15·1
5·747 10·5		5·682 15·0
5·719 10·6		
5·705 10·6		
5·729	5·610	5·675

Total, 41 weighings. Mean of all, 5·644.

II. β CdI_2.

E_1.	E_2.	I.
4·618 14·0°	4·598 15·2°	4·697 18·8°
4·607 14·4	4·594 15·3	4·713 18·9
4·609 14·7	4·601 15·2	4·740 19·0
4·618 15·0	4·602 15·2	4·668 19·0
4·612 15·1	4·592 15·4	4·625 18·9
4·615 15·1	4·593 15·4	
4·605 15·2	4·595 15·2	
4·612	4·596	4·688

Total, 19 weighings. Mean of all, 4·626.

Molecular volume α salt .. .. 64·8
,, ,, β ,, ... 79·2

Mol. vol. $Cd+I_2$, 64·3, when sp. gr. iodine = 4·948 (Gay-Lussac), and sp. gr. Cd = 8·655 (Matthiessen).

In connection with these experiments a little work was done upon the double iodides of cadmium. Attempts were made to prepare such double salts with the iodides of lead and of thallium, but unsuccessfully. Mercuric iodide dissolved freely in a hot solution of cadmium iodide, and the liquid upon cooling deposited scarlet crystals of the first-named salt unaltered. The mother-liquor from these crystals, upon longer standing, yielded golden laminæ, which were re-crystallisable from hot alcohol. They were anhydrous, and contained iodine, cadmium, and mercury. A partial analysis pointed to the formula $CdI_2.3HgI_2$.

	Found.	Calculated.
Cadmium	6·90	6·48
Iodine	58·80	58·98
Mercury	34·30 (by diff.)	34·54
	100·00	100·00

There was not enough of this salt to admit of further investigation.

With other iodides we have not yet gone very far. Zinc iodide, prepared by direct union of the elements and sublimation in a stream of carbon dioxide, has a sp. gr. of 4·666.* Bödeker found a sp. gr. of 4·696. For a some-

* Value actually found, 4·736. This was corrected for 3·13 per cent of admixed metal, becoming 4·666. There were six concordant estimations.

what impure bismuth iodide from Schuchardt we found the sp. gr. to be 5·548. Bödeker's value was 5·652.

With stannic iodide we are still engaged. Suffice it to say that we are satisfied of the existence of at least two modifications, one darker red and less soluble in benzene than the other. But the difficulty of obtaining pure and definite products is very great, and we may not have time to complete the investigation. — *American Chemical Journal*, vol. v., No. 4.

ON THE

USE OF MERCURY THERMOMETERS, WITH PARTICULAR REFERENCE TO THE DETERMINATION OF MELTING- AND BOILING-POINTS.

By J. M. CRAFTS.

(Continued from p. 289).

The Rise of the Zero-point.

After a depression of the zero-point, if the thermometer is left at the ordinary temperature, the zero is found to gradually rise through a tendency to return to its original position,* and the study of such movements as may be produced by exposing a thermometer during a very long time to constant temperature gives the data for calculating the position of the zero-point under all circumstances, and what is more important, the study of this question leads to the discovery of the means for preventing those variations of the constants of a thermometric scale which are fatal to the precision of all measurements. It is particularly from this point of view that we are interested in the subject, and only those details will be given which have a direct bearing upon improvements in the manufacture of thermometers.

If after a depression produced by heating a thermometer is heated at a lower temperature, the zero-point tends to gradually return to the position which is normal for this last temperature. The complete return or rise of the zero is more rapid in proportion as the temperature which produced the depression is not far removed from that which brings about the rise. The time required for this movement is measured by hours at the highest temperatures and for small intervals (10° to 20°), and by days or months at lower temperatures (100° or the ordinary temperature). When the interval is very large a part of the depression produced at a high temperature is permanent at the lower temperature. Thus a thermometer heated at 355° may be left for an indefinite period at the ordinary temperature without showing a rise of the zero equal to more than one-half of the true depression, but this depression may be made to disappear entirely when the thermometer is heated methodically for several days at each of the temperatures 300°, 250°, 200°, and so forth, to the ordinary temperature.

When a new thermometer is heated during a week or ten days at 355° a very considerable rise of zero is noticed. In the case of soda glass the zero may rise 10° or 15°, and with crystal glass 15° to 26°. This movement is probably the return from a depressed position, like those which have been previously described, and it may be assumed that the depression of the zero or the abnormal expansion of the glass was produced during the operation of blowing the bulb of the thermometer, and that it has resulted from the rapid cooling of the glass while still soft. Moreover, as it has been seen that the depressions of the zero-point produced at 355° or 300° persist at the ordinary temperature, so also this abnormal expansion produced at a red-heat is permanent at low temperatures. And it is in accordance with the rule derived from the previous results that the abnormal expansion should disappear when the thermometer is heated to a temperature nearer to that which produced the expansion. Thus the extraordinary rise of the zero-point which may be produced by heating to 355° or higher temperatures is probably almost entirely due to the same causes which induce the permanent elevation of the zero-point at the ordinary temperature, and the effects which previous observers have attributed to the pressure of the atmosphere are really due to an interior transformation* of the glass, almost or quite independent of external pressure. Thus similar results are obtained with vacuous or air-filled thermometers, and the progress of the changes, which have to do almost exclusively with the duration of time and the temperature to which a thermometer of a given kind of glass is exposed, is entirely under control.

Let us examine the rapidity of the change at different temperatures. The rise of the zero-point in a thermometer which is kept at the ordinary temperature becomes continually slower, and ceases to be appreciable after five or ten years. Thermometers have been observed for more than two centuries, and even after this great lapse of time the displacement of the zero is not more considerable. It usually attains about one-half a degree. In the same way the rise of the zero which is produced by heating to any fixed temperature tends to reach a limit, and the whole movement appears to be more rapidly completed the higher the temperature. On heating to 355°, after ten days, without having reached the limit, the thermometer may be considered as having become virtually stable, since the movement of the zero-point has become so slow that no noticeable displacement is produced during any ordinary experiments of short duration, even when the heat is carried as high as the boiling-point of mercury, and such a thermometer may be heated several days at 300° or 200°, or several months at 100°, or it may remain several years at the ordinary temperature without alteration to the effect produced at 355°. By this is meant that, although certain slight elevations take place at lower temperatures such as those which have been previously described, yet, whenever the thermometer is heated again to 355°, the zero-point immediately returns to the position which it had after the first prolonged heating in boiling mercury. It may be concluded from what precedes that the extreme variations of the zero-point to be observed with what has been called a stable thermometer, are comprised within limits of about 2° between the point of extreme depression for 355°, and a complete return to the higher position corresponding with the ordinary temperature, and the table of depressions gives the point within these limits to which the zero may be brought and permanently fixed by heating

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* I have followed this movement under varied conditions in order to ascertain if it is regular, *i.e.*, if the experiments can be so arranged as to give identical results under conditions which appear to be similar. In more than 1000 observations the divergences which escape a control of this sort do not appear to exceed 0·02° to 0·03°, but it would be very difficult to find a general formula for a movement which not only depends upon the time but also upon the temperature, and it must also be remembered that the depressions whose disappearance constitutes the phenomenon to be observed are often due to successive heatings at various temperatures, and represent the accumulation of several different impulses. Mr. Mills in a general formula for the rise of the zero-point at the ordinary temperature appears to have taken into account no factor except the time.

* Dr. Löwenberg (*Berichte Chem. Gesel.*, x., 472) supposes that the particles of glass after heating are in a state of tension produced by the slight conductibility of glass, which occasions a cooling or setting in successive layers, and that this abnormal tension may disappear in consequence of oft-repeated molecular movements. I am unable to estimate the consequences which follow upon this manner of considering the phenomena, but the following experiment was suggested by M. Dufour's observations upon rapidly cooled glass drops. He found that these drops contain a vacuous cavity, and consequently that after the solidification of the outside layer the interior mass must solidify under a diminished tension. It occurred to me to examine whether the exterior layer of the bulb of a thermometer exercises mechanical pressure on the interior layers: the result was negative. A large thermometer, newly made, was left in hydrofluoric acid until about one-third of the thickness of the bulb was dissolved, and no considerable change in the position of the zero took place. Care was taken to open the stem before the experiment in order to guard against the effect of the pressure of the atmosphere upon the bulb, made thinner by the action of the hydrofluoric acid.

at any constant temperature.* Similar series of observations were made with exactly similar results when, instead of 355°, the highest limit of temperature was fixed at 300°, 260°, 200°, or 100°.

It will be seen that only thermometers that have thus been made stable can be used where the position of the zero is to be determined by calculation, and what is more important it is that only with such instruments is the value of the degree constant, and that with constant thermometers any table of corrections obtained by comparison with an air thermometer remains permanently applicable. It may be added that the curve of corrections for thermometers that have been so heated as to produce the largest displacement of their zero-point does not vary in form from the curves of corrections to be applied to new thermometers to bring their scale into accordance with that of a gas thermometer. Five of the thermometers which were used in my experiments to compare the mercury with the hydrogen thermometer were subjected to a prolonged treatment at high temperatures, and the curve of average corrections obtained with these five instruments was found not to differ essentially from the average corrections determined from the other thermometers.

The Preparation of Thermometers.

The conclusions to which the preceding paragraphs lead may be summed up in a few general directions for rendering thermometers unchangeable. Those which are intended for the ordinary experiments between zero and 360° should be heated throughout the whole length of their stem for a week or ten days in boiling mercury, and the graduation, the determination of 100° and zero-points, and the calibration, should be made after this treatment; they then acquire a permanent value. When the scale only extends to some lower temperature, 200° or 100°, the time required for the preliminary treatment is proportionally longer. To prepare a standard thermometer for use at temperatures between zero and 100° it should be heated throughout its length for several weeks at 100°, or the process may be shortened by heating it in essence of turpentine at about 156° for four days, and then for a week at 100°.

The thermometers must not in any case be subjected for a long time to the action of water, and all these operations can be most conveniently carried out with a metallic apparatus, which is similar to that described further on for fixing accurately certain temperatures, except that many of the precautions there recommended for avoiding slight variations may be omitted. A cylindrical vessel of copper or iron with an hermetically fitting cover communicates with the air by means of a tube, upon which is fixed a condenser, so that evaporation is prevented and the heating at a constant temperature may be prolonged for any length of time. The thermometers are placed in an interior tube closed at the bottom and fitted into the cover with a perfectly tight joint. All the joints are brazed when the apparatus is made of copper. They are fitted by grinding and sweating on when the apparatus is made of iron. These pieces of apparatus have been found most convenient for heating sealed tubes or for any laboratory work where a fixed temperature is required. By the use of several substances, boiling under varied pressures, any temperature can be maintained constant for days or months to within one-fifth degree. They require no attention to regulate temperature, they are quickly heated and cooled, and if the sides are properly protected by a non-conducting jacket they are much more economical of gas than any oil or air-bath used for similar purposes. This mode of maintaining fixed temperatures, which was first studied by Regnault, cannot be too highly recommended for laboratory work.

A tight-fitting apparatus for boiling mercury is difficult to construct, and when it is only to be used to prepare "constant" thermometers for graduation (but not to graduate them), it suffices to use an iron tube closed by welding at the bottom, 5 or 6 c.m. wide and 1 metre long, filled with mercury to a height of 5 c.m. This lower portion is heated directly over the lamp. A non-conducting jacket protects a length above this of 60 c.m., and the mercury condenses in the upper part of the tube, which is exposed to radiation. Or in case mercury fumes are to be feared, the upper end of the tube can be surrounded by a condenser. The thermometers are enclosed in a sealed glass tube. A similar form of apparatus has been found most convenient for boiling sulphur and other substances in Victor Meyer's vapour-density determination.

Corrections to be applied to the Results obtained with the Mercury Thermometer to bring them to the True Temperature as measured by a Hydrogen Thermometer.

Each mercury thermometer has its individual scale requiring somewhat different corrections, but since the publication of Regnault's memoirs it has been customary to distinguish two categories of thermometers according as the glass is crystal containing oxide of lead or is ordinary glass. The columns A and B in the table below contain the corrections of Regnault for crystal glass from the manufactory of Choisy-le-Roy, containing 34 per cent of oxide of lead, and for ordinary French glass.

Neither of these kinds of glass is now used to make thermometers. The crystal which is employed at Paris contains about 18 per cent of oxide of lead; the German soda glass is free from lead, but it is much more fusible than ordinary French glass, hence a revision of these tables has become necessary. The column C of the table was obtained by experiments with 14 crystal glass thermometers made at Paris, and with a soda glass thermometer made at Bonn. To use the table the number of degrees centigrade is read off on the mercury thermometer, the position of the zero is determined immediately afterward, and the correction if necessary is made for its displacement; then the corrections of the table, observing their signs + or −, are added to the numbers of degrees thus obtained, and give the temperature which would have been found by a hydrogen thermometer, supposing that the calibration and the interval 100° to zero of the mercury thermometer are exact.

Temperatures,—	110	120	130	140	150	160°
A ..	−0·05	−0·12	−0·20	−0·29	−0·40	−0·52
B ..	+0·02	+0·05	+0·09	+0·15	+0·20	+0·26
C ..	+0·02	+0·04	+0·09	+0·16	+0·25	+0·33

Temperatures,—	170	180	190	200	210	220°
A ..	−0·65	−0·80	−1·01	−1·25	−1·53	−1·82
B ..	+0·32	+0·37	+0·35	+0·30	+0·25	+0·20
C ..	+0·35	+0·34	+0·32	+0·27	+0·18	+0·08

Temperatures,—	230	240	250	260	270	280°
A ..	−2·16	−2·55	−3·00	−3·44	−3·90	−4·48
B ..	+0·15	+0·10	−0·05	−0·20	−0·38	−0·52
C ..	−0·02	−0·14	−0·26	−0·39	−0·50	−0·63

Temperatures,—	290	300	310	320	330°
A ..	−5·10	−5·72	−6·45	−7·25	−8·22
B ..	−0·80	−1·08	−1·45	−1·80	−2·40
C ..	−0·88	−1·21	−1·60	−2·03	−2·48

The immediate measures made with the thermometers referred to in the above table were corrected for errors of calibration and for errors in the value of the degree. This latter correction should always be made after determining the number of degrees corresponding with the interval 100° to zero, and the previous remarks upon the errors of calibration show how far it is necessary to take these into account in ordinary thermometric work. It will be seen

* This statement must be taken in conjunction with what has been previously said concerning the persistency of depression for long intervals of temperature, and the appropriate means of making them disappear.

that the corrections of the column C do not differ greatly from those found by Regnault with ordinary French glass, but are widely different from those of the column A.*

In my experiments the curves which represent the corrections for each thermometer show greater departures from the mean curve C as the temperatures increase, but the greatest differences found were only 0·3° at 200°, 0·5° at 300°, and 0·8° at 330°. These figures represent the extreme errors which are probable on using the column C to correct results with thermometers made at Paris. The German thermometer was not among those which showed the greatest divergence, so that the column C may be considered as applicable to soda glass thermometers, but some experiments made with a number of German thermometers induce me to believe that their average corrections should be slightly lower than those of the column C.

(To be continued.)

PROCEEDINGS OF SOCIETIES

CHEMICAL SOCIETY.

Thursday, December 20, 1883.

Dr. W. H. Perkin, F.R.S., President, in the Chair.

The following gentlemen were declared by the Scrutators, Messrs. Meldola and Williams, duly elected Fellows of the Society:—Messrs. W. P. Bloxam, A. Cobb, G. C. Chambers, A. E. Ekins, F. P. Haviland, F. Keeling, W. H. R. Kerry, J. J. Pilley, M. Percy, J. Phillips, A. W. Rogers, W. J. Saint, G. Smith, A. Smithells.

The following certificates were read for the first time:—J. H. Burland, R. A. Bush, T. R. Duggan, G. W. Gibson, F. W. Harris, C. W. Sutton. F. W. Tompson, E. W. Voelcker.

The President then called on Mr. C. O'Sullivan to read a paper entitled "*Researches on the Gums of the Arabin Group: Part I., Arabic Acid, its Composition, and the Products of its Decomposition.*" The author wishing to compare arabic acid with other bodies with which he was working, looked up the literature of the subject, but found the results obtained by previous observers so irreconcilable that he was forced to examine this substance for himself. The present paper contains the first results of this examination. The author has mainly followed the method employed by Neubauer. The gum is dissolved in the smallest possible quantity of water, and the solution decanted from any insoluble matter, twice or three times as much hydrochloric acid as is sufficient to convert the bases into chlorides is added, and the arabic acid then precipitated by an excess of alcohol. The curdy precipitate is washed with alcohol and pressed; it is then dissolved in boiling water, cooled, and alcohol gradually added with constant stirring. The liquid becomes miky, but no precipitate forms; a few drops of hydrochloric acid are added, when a curdy precipitate is produced. By the careful addition of hydrochloric acid the body can be precipitated in several successive portions. The author obtained four such precipitates, each portion was re-dissolved and re-precipitated several times, dehydrated with absolute alcohol, pressed, and dried over sulphuric acid. Thus treated the bodies are white, friable, soluble in water, and free from ash. By an optical examination and the analysis of their barium salts the author proved that he was dealing with a homogeneous body; the optical activities ranging from $[\alpha]j - 25{\cdot}7$ to $-27{\cdot}0$, and the percentages of barium oxide from 5·90 to 6·07. It occurred to the author that a careful study of the action of sulphuric acid might throw some light on the nature and composition of arabic acid, and that this body should yield a sugar or sugars, and a series of acids of gradually diminishing molecular weight; in fact that it would behave after the manner of starch (*Chem. Soc. Journ.*, 1876, ii., 125). 500 grms. of arabic acid $[\alpha]j - 27°$, which must be free from ash, were dissolved to 1500 c.c., and 40 grms. of sulphuric acid in 150 c.c. of water added. The mixture was boiled for three hours, cooled, and exactly neutralised with a hot solution of barium hydrate. The barium sulphate filtered off, the filtrate evaporated to 1000 c.c., and alcohol sp. gr. 0·83 added as long as a precipitate fell. This waxy precipitate was repeatedly dissolved in water, re-precipitated by alcohol to free it from sugar, and dried over sulphuric acid. This white friable body, when dried at 100°, gave 14·57 BaO. The arabic acid molecule had therefore broken up: it remained to be proved whether the substance was homogeneous or not. It was dissolved in water, and fractionally decomposed by successive additions of sulphuric acid into three portions, A, B, and C. A contained 14·27 per cent BaO; B, 14·35 per cent; C, 15·46 per cent. Portion C was further separated into three. The first contained 15·27 BaO; second, 15·36 per cent; third, 15·54 per cent. it was therefore fairly homogeneous. A and B were mixed, and on fractionation it became evident that there were two salts, one containing 13·3 to 13·4 per cent BaO, the other 15·5 per cent BaO. The author then studies the further action of sulphuric acid on this 15·5 per cent barium salt. 20 grms. were dissolved in water, and 2·5 c.c. of sulphuric acid previously diluted with water added. The mixture was digested for three hours at 100°. By neutralisation and treatment as above, a salt was obtained containing 18·5 per cent BaO. This salt was submitted to combustion; it gave numbers indicating the formula $C_{23}H_{38}O_{22}BaO$; it is, therefore, not a carbohydrate, but differs from the carbohydrate $C_{24}H_{40}O_{2C}$ by the subtraction of CH_2 and addition of O_2. The alcoholic solution from which this salt had been separated was freed from alcohol, the residue concentrated to a syrup, purified, and allowed to crystallise, when a sugar of the class $C_6H_{12}O_6$ separated out. Its optical activity was $[\alpha]j$ 79° to 81°, and copper reducing power K=81 to 82. The salt containing 15·5 per cent BaO was next dried and analysed; it gave a formula $C_{29}H_{48}O_{27}BaO$. The 18·5 per cent BaO salt was doubtless, therefore, derived as follows:—

$$C_{29}H_{48}O_{27}BaO + H_2O = C_{23}H_{38}O_{22}BaO + \underbrace{C_6H_{12}O_6}_{\delta\ \text{arabinose.}}$$

The 13·3 barium salt corresponds to the formula—

$$C_{35}H_{58}O_{32}BaO.$$

so that we have the series—

$$C_{23}H_{38}O_{22}BaO + C_6H_{10}O_5 = C_{29}H_{48}O_{27}BaO$$
$$C_{29}H_{48}O_{27}BaO + C_6H_{10}O_5 = C_{35}H_{58}O_{32}BaO.$$

The high molecule being broken down with the elimination of $C_6H_{10}O_5$, which is hydrated to a sugar of the $C_6H_{12}O_6$ class: it appeared probable that the arabic acid molecule was broken down in the same way, and that its composition would be arrived at by adding such a multiple of $C_6H_{10}O_5$ to one of these barium salts as would give a compound containing the same quantity of BaO as barium arabate. To obtain further evidence of this disintegrating process, 200 grms. of pure arabic acid $[\alpha]j - 27°$ were dissolved in 300 c.c. of water, to which 10 grms. of sulphuric acid were added, and the whole was digested at 100° for one hour. The product was separated as before by fractional precipitation, and eventually two salts obtained, containing 11·35 per cent BaO and 13·38 per cent BaO. The latter was the salt already noticed, $C_{35}H_{58}O_{32}BaO$. The 11·35 per cent salt was analysed, and gave a composition $C_{41}H_{68}O_{37}BaO$—

$$C_{41}H_{68}O_{37}BaO + H_2O = C_{35}H_{58}O_{32}BaO + C_6H_{12}O_6.$$

The free acid of this salt was also prepared; its analysis

* It is not probable that these differences are to be attributable entirely to the composition of the glass, and in a paper published in the *Comptes Rendus*, November 6, 1882, I have pointed out certain features of Regnault's method of operating which lead me to suppose that his corrections are too high.

confirmed the above formula. At this point the author set to work to isolate the sugars which ought to be separated at the various steps of the disintegration of the molecule of arabic acid. Starting with the alcoholic solution from which the salt $C_{29}H_4O_{27}BaO$ had separated he succeeded in obtaining three sugars of the $C_6H_{12}O_6$ class, which he names β-arabinose, αj = 111·1° K=110; γ-arabinose, αj =91° K=99·4—to 100; and δ-arabinose αj =79° to 81°, K=81—82; and in proving the presence of α-arabinose with a greater optical activity than β-arabinose. The author then gives the results of six analyses of arabic acid. The numbers lead to the empirical formula $C_6H_{10}O_5$. Now a barium salt containing C.H.O in this ratio, and at the same time 6 per cent BaO, should be $C_{90}H_{150}O_{75}BaO$; but such a constitution does not lead to the highest acid, $C_{41}H_{68}O_{37}$, obtained in the decomposition products. Thus $C_{41}H_{68}O_{37}+8C_6H_{10}O_5=C_{89}H_{148}O_{77}$; but writing the equation thus—

$$C_{41}H_{68}O_{37}+8C_6H_{10}O_5=C_{89}H_{142}O_{74}+3H_2O,$$

we obtain a formula for arabic acid $C_{89}H_{142}O_{74}$, which fits exactly with the combustion percentages, and requires 6 per cent BaO, the numbers obtained being 6·10, 5·90, 6·00, 6·06. The calcium salt was prepared, and gave similar results. Arabic acid may therefore be represented by $C_{89}H_{142}O_{74}$. Finally, the author made a successful attempt to isolate the acids intermediate between arabic acid and the $C_{41}H_{68}O_{37}$ acid. 60 grms of pure arabic acid were dissolved in 200 c.c. of water containing 4 grms. of sulphuric acid, and digested for fifteen minutes at 100° C. Two barium salts were obtained containing 6·45 p.c. BaO and 7·36 per cent, corresponding respectively to—

$$C_{83}H_{132}O_{69}BaO \text{ and } C_{71}H_{112}O_{59}BaO.$$

β-arabinose αj 111·5° K110 was also isolated, and evidence obtained that α-arabinose αj 140° was present. Neither γ nor δ arabinose was detected. The author then gives a summary of this most important paper, respecting the decompositions of arabic acid by sulphuric acid.

(I.)
$$\underbrace{C_{89}H_{142}O_{74}}_{\text{Arabic acid.}} + H_2O = \underbrace{C_{83}H_{132}O_{69}}_{\alpha\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\alpha\text{-arabinose.}}$$

(II.)
$$C_{83}H_{132}O_{69} + H_2O = \underbrace{C_{77}H_{122}O_{64}}_{\beta\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\alpha+\beta\text{ arabinose.}}$$

(III.)
$$C_{77}H_{122}O_{64} + H_2O = \underbrace{C_{71}H_{112}O_{59}}_{\gamma\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\beta\text{-arabinose.}}$$

The next five steps have not been followed, and so are united:—

(III. to VIII.)
$$C_{77}H_{122}O_{64} + 9H_2O = \underbrace{C_{41}H_{68}O_{37}}_{\theta\text{-arabinosic acid.}} + \underbrace{6C_6H_{12}O_6}_{\beta,\gamma,\delta,\text{ and other arabinoses.}}.$$

(IX.)
$$C_{41}H_{68}O_{37} + H_2O = \underbrace{C_{35}H_{58}O_{32}}_{\iota\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\delta\text{-arabinose (?).}}.$$

(X.)
$$C_{35}H_{58}O_{32} + H_2O = \underbrace{C_{29}H_{48}O_{27}}_{\kappa\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\delta\text{-arabinose (?).}}.$$

(XI.)
$$C_{29}H_{48}O_{27} + H_2O = \underbrace{C_{23}H_{38}O_{22}}_{\lambda\text{-arabinosic acid.}} + \underbrace{C_6H_{12}O_6}_{\delta\text{-arabinose.}}.$$

This last arabinosic acid, $C_{23}H_{38}O_{22}$, is a very stable body, resisting the action of 3 per cent to 4 per cent solution of sulphuric acid for many hours. It probably splits up in a more complicated way than its predecessors. Arabic acid αj −27° to −28° is the chief constituent of all the lævo-rotatory gums; other acids are present which bear a simple relation to it. In a future paper the author promises an account of dextro-rotatory and optically inactive gums, the acids of which are built up in the same manner as arabic acid.

Dr. Armstrong said the paper was one of the utmost importance, and was the more interesting as it had been read by the chemist who first enlightened us as to the constitution of starch in 1876. He then contrasted the results of the present paper with those obtained in the case of starch, and pointed out the probability that starch has a very high molecular weight.

Dr. Ramsay then read a paper entitled "*The Decomposition of Ammonia by Heat*," by W. Ramsay and S. Young. The results obtained may be summed up as follows:—When ammonia gas is passed through a porcelain tube, or an iron tube, or a glass tube, filled with asbestos card-board, the amount of decomposition at 500° to 520° is nearly equal and very small. Ammonia, therefore, begins to decompose a little below 500°. In contact with a glass suface the temperature at which decomposition begins is much higher; the amount of decomposition depends on the rate of passage of the gas and on the nature of the surface. Thus ammonia is completely decomposed by passage through a plain iron tube heated to 780°. By passing ammonia through a glass tube containing iron wire at 760°, 76 per cent of the ammonia was decomposed; with copper wire under similar conditions only 2 per cent was decomposed.

Mr. Warington pointed out the importance of these results in connection with the now common practice of making soda-lime combustions in iron tubes.

Prof. Foster made some observations as to the bearing of these experiments on the quantity of ammonia obtained in the distillation of coal.

Dr. Ramsay then read a paper "*On the Halogen Compounds of Selenium*," by F. P. Evans and W. Ramsay. The authors first prepared the selenium mono-chloride, Se_2Cl_2, which splits on distillation into selenium and selenium tetra-chloride; the tetra-chloride is insoluble, the mono-chloride soluble in carbon disulphide. The selenium dichloride could not be prepared. Selenium tetra-chloride begins to decompose at 288°. The authors have also prepared selenium chloro-tribromide and the bromo-trichloride.

"*On the Preparation of Pure Chlorophyll*," by Dr. A. Tschirch. The author states that chlorophyll is very unstable, being decomposed by acids and alkalies. He has prepared it by reducing chlorophyllan (*Botan. Zeitung*, 1882, 533) with zinc dust. The chlorophyll so obtained gives a spectrum identical with that given by living leaves.

The Society then adjourned to January 17th, 1884

NOTICES OF BOOKS.

Poisons; their Effects and Detection. A Manual for the Use of Analytical Chemists and Experts, with an Introductory Essay on the Growth of Modern Toxicology. By Alexander Wynter Blyth, M.R.C.S., F.C.S., &c. London: C. Griffin and Co.

We have here a sound, practical, and thorough-going manual of toxicology, and of something more. The author does not merely expound the most approved methods for the detection of poisons, whether in a separate state or in mixtures of organic matter. He describes their physical and chemical properties, the symptoms which they produce when conveyed into the human and animal system, the purposes to which they are applied in the arts, and the channels through which they may be introduced into articles of food, &c. There is also a brief abstract of the British, German, and French law on poisoning, and under several heads we find notices of the possible lines of defence which may be set up in criminal proceedings. The work, as will doubtless be remembered,

formed in its original state a part of the author's "Practical Chemistry." The great importance and the special character of the subject have necessitated its appearance, greatly enlarged and indeed re-written as an independent work.

The book begins with a very interesting historical introduction. We have here the poison-law of the Egyptians, Greeks, Hebrews, the Eastern Nations, of Rome under the empire, of the middle ages, and of modern Europe.

Here figure naturally the professional poisoners of Italy in the seventeenth century, among whom figure John of Ragubo, and the far-famed Toffana, whose "water," the Aqua Toffana, or *Acquetta di Napoli*, was widely dreaded. A little later flourished A. Croix and his paramour, the infamous Madame de Brinvilliers, who seems to have occasionally poisoned inoffensive persons as a matter of experiment.

In the next section, which describes the progress of modern toxicology, we have an account of the researches in the direction of Scheele, Proust, Serullas, and Marsh. This last chemist, it is said, was not the original discoverer of the test which bears his name. He merely perfected the process and brought it into general notice. The true father of toxicology as now practised was M. J. B. Orfila. To him is due the capital discovery that poisons when taken become absorbed and localised in certain organs, which it is accordingly necessary to examine. Previously, the chemist, if unable to detect poison in the contents of the stomach, or in vomited matter, did not trouble himself with the brain, the liver, the blood, &c., and so the substance in question might often escape detection.

We then come to the definition of poison, both from a legal and a scientific point of view. The English law holds a poison to be any destructive thing administered to and taken by a person. Hence, as the author shows, the legal notion of poison would include, in addition to substances which act in virtue of their chemical nature, "boiling water, molten lead, specifically infected fluids, the flesh of animals dying of diseases which may be communicable to man, powdered glass, diamond dust, &c." The law also, as now existing, covers the introduction of noxious matter into the body, not merely by the mouth, but by any and every possible channel. The laws of Germany and of France take, substantially, the same ground.

The scientific definition of poison is, however, totally different; it must exclude substances which injure mechanically, like powdered glass; physically, by their high temperature or by their physiological character. This author proposes the following definition:—"A substance of definite chemical composition, whether mineral or organic, may be called a poison if it is capable of being taken into any living organism, and causes, by its own inherent chemical nature, impairment or destruction of function."

In explanation it must be noted that Mr. Blyth considers the poisonous secretions of animals and vegetables as containing some definite chemical compound, or a mixture of several such compounds upon which their efficacy depends.

Such bodies consequently do not possess the power of reproduction and cannot multiply in the remains of the animal destroyed. Further—an important practical conclusion—they cannot be combatted by agents of the antiseptic class, such as phenol, salcylic acid, &c.

The author's classification of the poisons is of a purely practical nature, being based upon the procedures to be used in their detection. On this principle he places firstly the stronger acids and alkalies; next follow volatile poisons capable of being separated by distillation from neutral or acid liquids; thirdly, alkaloids and poisonous vegetable principles separable for the most part by alcoholic solvents; fourthly, poisons derived from living or dead animal substances; and lastly, the inorganic compounds.

It will be found on an examination of this book that the number of poisons is far greater that is commonly supposed. As most of these substances have abundant uses in the industrial arts perfectly independent of their effects upon the animal organism, the impolicy, not to say the impossibility, of sweeping restrictions upon their sale is obvious. We are sorry to find that not a few medical men and pharmacists continue to agitate in this direction. Nor must it be overlooked that certain principles, *i.e.* vegetable acids, which occur in ordinary articles of human food, are quite capable of proving fatal if taken in sufficient doses. It seems to us grossly inconsistent to propose prohibitive regulations for the disposal of the mineral acids and yet tolerate the common sale of ammunition and explosives—articles far more dangerous to the public and far less generally useful in civil life.

One of the chief merits of Mr. Blyth's book is that it discusses certain substances which have been overlooked in many manuals of toxicology.

Thus, chromium and its compounds are here, for the first time, we believe, in any English work, considered in some detail. That they should hitherto have been overlooked is strange in view of the fact that it is a powerful irritant, and that it is used in the Arts on a very large scale, finding its way by the waste waters of dye-works into the streams. What are its effects upon vegetable life, and whether, if so, to what extent it is capable of being absorbed by plants, it has not been ascertained. Mention is here made of the chronic poisoning sometimes experienced by workmen at the manufactories of the bichromate. The principal feature here is destruction of the septum of the nose. It is said, though the author does not vouch for the accuracy of the statement, that "when a man has thus lost his nasal septum he no longer suffers from nasal irritation, and has a remarkable immunity from catarrh."

The hands of the workmen engaged in dyeing chrome blacks, on woollens and worsteds, and still more those who dye chrome yellows and oranges on cottons, are often severely ulcerated. The mischief may extend, it is said, to the entire destruction of the fingers. We never, however, obtained complete evidence of such a case, and in all well managed dye-works, a man who is found specially amenable to the poison is at once removed to some other department of the business.

Another, little known, though very common and deadly substance, is barium in its soluble compounds. It is also procurable in certain districts without the risk of purchase. There are parts, both in England and Scotland, where the native barium carbonate, witherite, may be picked up by the road-side.

Among better known substances arsenic, which may almost be considered as our national poison, is treated of at great length. First, we find the question of the solubility of arsenious acid—a point of some importance in Madeline Smith's case. By boiling, water may be made to retain 2·01 to 3·3 per cent of the anhydride. What influence, if any, the presence of different kinds of organic matter may have upon its solubility, the author does not attempt to decide.

The effects of arsine appear to be very variable. Nine workmen were poisoned more or less severely in consequence of inhaling the fumes given off on treating arseniferous silver lead with hydrochloric acid,—an operation which should have been performed under a very powerful draft-hood. Three of the patients died and the others recovered after several months' illness.

The action of arsenic by plants and its possible assimilation meets with due notice. The results obtained by different chemists are not accordant, and there is hence scope for further research. E. Davy, Tuson, and Andonard maintain that plants may take up arsenic if manured with superphosphate which has been prepared with arseniferous sulphuric acid. On the other hand, Gorup-Besanez maintains that if arsenious acid be mixed with earth, plants growing in such soil take up only infinitesimal quantities of the poison. It is fully established that plants die if their root or stem be placed in aqueous

solution of arsenic. But it is still an open question whether they may not gradually, like certain animals, be brought to tolerate this substance if applied in minute proportions. This matter deserves the most careful investigation, as food-plants are now brought in contact, not merely with possibly arseniferous superphosphate, but with copper arsenites (Paris green) used to kill destructive insects.

The existence of the practice of arsenic-eating, which was at one time contemptuously denied, is now placed beyond all doubt. This fact, like the possible, if not probable, occurrence of arsenic in vegetable matter, may, in a case of poisoning, suggest lines of defence which the expert will do well to take into consideration. As the author also points out, the inhalation of the fumes from arsenical candles or emanations from wall papers, &c., and, in the case of an exhumed body, the possible entrance of arsenic into the corpse from the soil of the cemetery, may also be brought forward to account for the presence of the poison.

As regards cantharides, an interesting fact is made known. Upon fowls, turkeys, and frogs these beetles have no action. Yet, persons subsequently eating the flesh of such animals may be seriously affected. Thus, French military surgeons, in Algeria, occasionally meet with inflammation of the bladder among the soldiers. This is "caused by eating frogs in the months of May and June; the frogs living in those months almost exclusively upon a kind of cantharides."

The ptomaines and the poisons of snakes are discussed with great ability. Into these subjects space does not allow us to enter further than by mentioning that Dr. Shortt, and subsequently the author himself, had anticipated the researches of Dr. Lacerda on snake-poisons. His alleged remedy, potassium permanganate, though it destroys the poisons if mixed with them in a concentrated form, has no antidotal powers when injected into the human body.

In conclusion, we must pronounce Mr. Blyth's work as one which cannot be too warmly recommended to medical practitioners and chemical analysts who may come in professional contact with poisoning cases.

CORRESPONDENCE.

DETECTION OF ALBUMEN IN URINE.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlvii., p. 239, there appears "A New Test for Detecting Albumen in Urine." Considering that phosphates, in one form or another, are always present in urine, I fail to see the value of the test. The acetic acid which the author adds certainly cannot prevent the precipitation of iron phosphate. If I may, I should like to ask what his further experience on this point has been,—I am, &c.,

W. P. Mason.

Winslow Laboratory,
Rensselaer Polytechnic Institute,
Troy, N.Y., Dec. 7, 1883.

NEW ACID IN TOBACCO LEAF.

To the Editor of the Chemical News.

Sir,—Please insert following note in your next issue as claim to priority:—

The writer has been engaged for some time in the study of an acid present in tobacco leaf, which bears the closest resemblance to caffetannic acid, and also to pyrocatechol. It is combined in the leaf with some base, perhaps nicotine. Its further study is being continued.—I am, &c.,

T. J. Savery.

Royal Agricultural Society's Laboratory,
12, Hanover-square, Dec. 21, 1883.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, Vol. 16, No. 6.

Hydroxylamine Reactions.—V. Meyer.—A. Müller has examined the action of hydroxylamine upon phenylglyoxylic acid and other ketonic acids. Lævulic acid yields a finely crystalline iso-nitroso-valerianic acid. Mesoxalic acid, benzoyl-cyanide, and glyoxalic acid react easily and yield characteristic products.

On the Aldoximes.—J. Petraczek.—An account of benzaldoxime, its behaviour with hydrochloric acid and sodium salt of benzaldoxime and its reactions with solutions of the heavy metals. The author describes the methyl-ether of benzaldoxime, the decomposition of methylbenzaldoxime by acids, methyl-hydroxylamine hydrochlorate, the ethyl-ether of benzaldoxime, its propyl-, isobutyl-, and allyl-ethers and iso-amyl-aldoxime.

On Diethyl-acetacetic Acid.—M. Ceresole.—An account of this acid and of its barium salt.

Ethers of Iso-nitroso-acetone.—M. Ceresole.—The author describes the methyl and ethyl-ethers of iso-nitroso-acetone, the methyl ether of iso-nitroso-methyl-acetone, the benzyl ether of benzyl-iso-nitroso-acetone, and adds remarks on the formation of the salts of the iso-nitroso-ketones.

Formation of Acetol from Sugar.—A. Emmerling and G. Loges.—The authors obtain acetol both from grape-sugar and cane-sugar, and finds both identical with each other and with the alcohol of acetone.

On Chloride of Lime and Analogous Bodies.—G. Lunge and P. Naef.—The authors infer from their experiments that the bleaching-compounds obtained from the bivalent metals, calcium, strontium, and probably barium, have in all probability the nature of double salts of the formula Cl ... R .. O Cl, in which all the chlorine can be directly replaced by carbonic acid. The formula for chloride of lime, first proposed by Odling—

Cl — - — Ca — - — O Cl,

must be still retained, as all Kraut's objections against it have been completely refuted.

Schizomycetic Fermentation.—Albert Fitz.—In the schizomycetes as well as in *Bacillus butylicus* the power of setting up fermentations is signally enfeebled by culture at high temperatures and with abundant access of oxygen.

On Dinitro-cinnamic Acid.—P. Friedlaender and J. Mähly.—The authors prove that a compound which they have described in former communications is dinitro-cinnamic acid by its reduction to a diamido-hydro-cinnamic acid. They describe para-nitro-benzaldehyd, dinitro-cinnamic ether, dinitro-cinnamic acid, dinitro-styrol, dinitro-phenyl-β-ethoxy-propionic ether and diamido-hydro-cinnamic acid.

On α-Mono-chloro-cinnamic Acid.—C. Forrer.—The author's mono-chloro-cinnamic acid is identical with that of Jutz.

Ethers of Phthalic Acid.—C. Graebe.—The author considers it probable that there exist two series of the ethers of phthalic acid.

Compound Isomeric with Euxanthon.—C. Graebe.—The author has obtained this isomer in an attempt to prepare euxanthon synthetically. He purposes continuing his researches.

Joint Oxidation of Aromatic Diamines and Monamines; a contribution to the Knowledge of the Saffranines.—R. Bindschedler.—The author discusses

here the oxididation products of dimethyl-para-phenylen-diamine and dimethyl-aniline; of the first-mentioned compound with dimethyl-aniline and aniline, with aniline alone and of para-phenylen-diamine and aniline. The details will be given in the *Annalen der Chemie*.

Contribution to the Quantitative Analysis of Chocolate.—R. Bensemann.—The author contends that the determination of fatty matter and theobromine in a chocolate is no certain guide to the quantity of cacao present. He proposes to determine the percentage of organic matter insoluble in water, of fat, and of starch. He gives the composition of several chocolates in which the cacao ranges down to 12·6 per cent, whilst the farina mounts up to 31·5.

Nitro-derivatives of Resorcin.—C. Schiaparelli and M. Abelli.—The authors effect the separation of styphnic acid from dinitro-resorcin by means of repeated crystallisation from alcohol.

Structure of the Hydroxylamine Derivatives.—W. Lossen.—This memoir does not admit of useful abstraction.

Salts of Ethylen-diquinoil and Methylen-diquinoil.—O. Rhoussopoulos.—An account of ethylen-diquinoil hydrochlorate, the corresponding hydrobromate, and hydriodate.

Action of Chrorsl upon Chinoline.—O. Rhoussopoulos.—On mixing the two liquids there is formed a white, butter-like mass, insoluble in almost all solvents. On treatment with strong hydrochloric acid there is obtained a white compound consisting of minute crystalline leaflets.

Compounds of Chinoline with Phenols.—K. Hock.—The author has obtained a compound of 2 mols. chinoline with 1 mol. resorcin. It is sparingly soluble in cold water, but readily in alcohol, ether, and chloroform. On prolonged boiling in water it is decomposed, chinoline being volatilised, whilst resorcine passes into solution.

Chloro-camphor and Nitro-chloro-camphor.—R. Schiff and J. Puliti.—The authors have obtained the same compounds of chlorine and camphor as those described in the *Comptes Rendus* by Cazeneuve, but by a different process.

Ammonium-Derivatives of Benzil and on the Formula of Benzil.—Th. Zincke.—M. Hænius, under the direction of the author, has studied the reactions of ammonia and the amines with benzil. The amines gave no reactions. The behaviour of ammonia with benzil had been previously studied by Laurent, who obtained three derivatives, imabenzil, benzilimide, and benzilam. According to Hænius these bodies really exist, but their composition differs from that assumed by Laurent.

On Chloro-naphtho-quinon-nitroso-anilide and on Oxy-naphtho-quinon-anilide.—A. Plagemann.—This paper is not adapted for useful abridgment.

Oxy-thymo-quinone from the dimethyl-amine-compound of Thymo-quinone.—H. Schulz.—Oxy-thymo-quinone crystallises from hot water or hot dilute alcohol in small, yellow, or brownish yellow needles. It is also soluble in ether, chloroform, and benzol. Its salts are not very characteristic.

Action of Strong Sulphuric Acid upon α-Nitro-anthraquinon-sulphonic Acid.—A. Claus and H. Engelsing.—By this reaction two hydroxyl-groups are introduced and the nitro- is at the same time reduced to the amido-group.

On Certain Derivatives of Anthraquinon-α-Disulphonic acid.—A Claus and E. Schneider.—The anthraquinon-disulphonic acids can be readily nitrised in the same manner as the corresponding mono-acid. If lead anthraquinon-α-disulphonate, suspended in water, is treated with sulphuretted hydrogen, an intense green solution is obtained, which if evaporated in an atmosphere of hydrogen leaves a residue of the same colour. If the green liquid is mixed with caustic potassa the colour turns to a deep red.

Behaviour of Para-brom-aniline with Sodium and Sodium-Propyl-bromide in Ethereal Solution.—A Claus and A. Rogues.—The author's experiments prove that under the above mentioned circumstances there is produced a secondary propyl-aniline. In the moment when the sodium removes the bromine from the bromaniline, immediately, and before the propyl-residue which is disposable has time, an amido-hydrogen atom takes the place of the eliminated atom of bromine on the bromine nucleus, and then secondarily a propyl-residue attaches itself to the nitrogen in the place of the hydrogen.

Action of Sodium and Methyl Iodide upon Meta-brom-para-toluidine, Acet-meta-brom-para-toluide, and Dimethyl-para-brom-phenylamine in Ethereal Solution.—A. Claus and A Steinberg.—Not suitable for abstraction.

Formaldehyd and Oxy-methylene.—B. Tollens.—The preparation of pure formaldehyd, or rather of oxy-methylene, must be effected at the lowest possible temperature, and with liquids previously concentrated as much as possible.

Behaviour of Dextrose with an Ammoniacal Solution of Silver.—B. Tollens.—One mol. dextrose precipitates 12 or 13 atoms of silver and takes up 6 atoms of oxygen. Much formic acid is produced in the reaction. Oxalic acid is also obtained. Glycolic acid has not been sought for. The author considers that dextrose cannot be regarded as an aldehyd.

Action of Dichloracetic Acid upon Aromatic Substituted Amines.—Paul J. Meyer.—The author examines the action of dichloracetic acid upon orthotoluidine, the result being diortho-toluido-acetic acid. With paratoluidine the result is an imesatine, containing in its nucleus an additional methyl-group.

Quinovine and Quinovaic Acid.—C. Liebermann and F. Geisel.—A very full account of α and β quinovine and of quinovaic acid. The authors remark that the by-products found along with the main constituents of plants are often of especial interest because they often bear to each other the same relations as do the main and the main and the secondary products of a chemical reaction.

Reduction of Nitro-toluol and Nitro-benzol.—H. Klinger.—An examination of a red, amorphous, indifferent substance, obtained by the action of sodium methylate upon para-nitro-toluol, and which the author regards as a tolylen-azoxy-tolyl.

Cosmos les Mondes.
No. 11, November 10, 1883.

This issue contains no chemical matter.

MISCELLANEOUS.

Royal Institution.—Mr. H. H. Johnston will give a discourse on "Kilima-Njaro, the Snow-clad Mountain of Equatorial Africa," on Friday Evening, January 25th: Professor Bonney's discourse on "The Building of the Alps," announced on that evening, will be given on April 4.

MEETINGS FOR THE WEEK

Monday, Dec. 31st.—London Institution, 5.
Tuesday, Jan. 1.—Royal Institution, 3. "Alchemy," by Prof. Dewar.
Thursday, 3rd.—London Institution, 7.
—— Royal Institution, 3 p.m. "Alchemy," by Prof. Dewar.
Friday, 4th.—Pathological, 8.30. (Anniversary.)
—— Geologists' Association, 8.
Saturday, 5th.—Royal Institution, 3. "Alchemy," by Prof. Dewar.

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THE QUALITATIVE AND QUANTITATIVE SEPARATION OF BISMUTH AND COPPER.

By Dr. JULIUS LÖWE.

SOME time ago the author communicated to this journal the observation that the oxides of bismuth and copper in solution are precipitated by soda or potassa in presence of glycerin, but are completely re-dissolved by an excess of the precipitant. In this alkaline solution both show a similar behaviour with a solution of glucose, being both reduced at a boiling heat, the copper to red cuprous oxide and the bismuth to grey, finely-divided metal. They differ, however, in their behaviour with glucose, in the cold or at a gentle heat; copper in the course of several hours being completely deposited in the form of red cuprous oxide, whilst the alkaline solution of bismuth undergoes no change. Not until after the solution has stood for some days are small quantities of the bismuth deposited in the metallic state. This reaction may be very conveniently used for separating copper and bismuth as well quantitatively as qualitatively from a mixed solution in nitric acid, in all cases when the bismuth predominates.

For this purpose the nitric solution, not too acid and not too concentrated, is placed in a beaker and mixed with a measured volume of soda-lye until the oxides are precipitated and the supernatant liquid shows an alkaline reaction. During this process the temperature must not be allowed to rise. Then double the volume of the lye consumed is added, and pure, syrupy glycerin is then stirred in until the oxides are completely re-dissolved and the liquid becomes clear. This deep blue solution is mixed with a solution of pure glucose (1 part in 6 to 8 parts of water) in such a proportion that the sugar may amount to three to four times the joint weight of the metals. The beaker is then covered with a well-fitting glass plate, and the liquid is let stand 8 to 10 hours in a cool, dark place. The blue colour is then found to have given place to a deep yellow, whilst the copper is deposited at the bottom of the beaker as a bright red oxide, mostly not adhering to the glass. The yellow liquid is poured off, without stirring, upon a filter which has been dried at 100° and weighed. The cuprous oxide is washed by decantation, first with water, containing a little glycerin, and soda-lye, collected upon the filter, and then well washed with distilled water. After the last portions of washing-water, which should be free from alkaline reaction, are run off, the filter is cautiously lifted out of the funnel, laid upon good absorbent paper, and then dried at 100° in the air-bath. The increase of weight of the filter gives the quantity of red oxide, 100 parts of which represent 88·8 parts of metallic copper.

Where greater accuracy is required the red oxide obtained after weighing is converted into oxide in the ordinary manner after incineration of the filter, &c., and the copper is determined in its solution by any ordinary method.

The alkaline filtrate, containing all the bismuth, is placed in a sound, well-glazed porcelain capsule, heated to a boil over a free flame, stirring gently, kept at this temperature for a short time, removed from the source of heat, and the brownish liquid is allowed to cool and settle. It is then filtered through a filter which has been dried at 100° and weighed. The metallic bismuth is first washed by decantation with water containing soda, collected on the filter, and further washed first with cold and then with hot water. The drying is effected as in the case of the cuprous oxide, and the increase of weight of the filter gives the quantity of the bismuth.

The glaze of the porcelain capsule must be of the best quality, lest any particles of metal may be deposited upon it and prove hard to remove. The metal is also reduced in the water-bath, but less rapidly than over the naked flame.

The finely divided metallic bismuth must be washed and dried as rapidly as possible, so as not to remain too long in contact. The filter must be of the best paper, as the fine metallic particles may otherwise easily pass through.

If the weight of the bismuth is decidedly greater than that of the copper this process yields very satisfactory results. The author purposes to make further investigations on the converse case.—*Zeitschrift Analyt. Chemie.*

DETECTION OF CHLORINE, BROMINE, AND IODINE.

By FRANCIS JONES, F.R.S.E.

IN the December number of the *Journal of the Chemical Society* some experiments are described on a process due to Vortmann, for the detection of chlorine, bromine, and iodine in mixtures. I have lately introduced a method (suggested to me by the process employed on the large scale for the manufacture of iodine and bromine) which is based on the same principle, but carried out in a simpler and more convenient manner, and which serves extremely well for the detection of the three elements. The process is carried on in the following way:—Place a *small* quantity of the mixture to be tested in a good sized test-tube, add a few pieces of manganese dioxide and then a little water. Add now *one* drop only of dilute sulphuric acid (one part acid to ten of water); a brown tinge indicates the presence of iodine. Boil the mixture, and confirm the presence of iodine by the violet vapours in the upper part of the tube. Continue the boiling till these vapours cease to appear, then add another drop of sulphuric acid and boil again till they cease. If necessary repeat this addition of acid and boiling until violet vapours have entirely ceased. Now add about two cubic centimetres of the dilute acid and boil again: brown vapours indicate bromine. Continue the boiling until the vapours no longer smell of bromine, then add one cubic centimetre dilute acid and boil again. When the vapours no longer smell of bromine allow the residue to cool *completely*; add an equal bulk of *strong* sulphuric acid and warm; a green gas bleaching a piece of moist red blotting-paper at the mouth of the tube indicates chlorine.

Occasionally some bromine comes off on addition of the strong acid, but if so it is soon got rid of, and is succeeded by the chlorine, which is chiefly evolved on warming the mixture. As, moreover, moist red blotting-paper is far more quickly acted on by chlorine than by bromine, there can be no difficulty in distinguishing between the two elements.

I have compared the results obtained by my students when using this and other methods, and find they are far more successful with the new method.

SEPARATION OF STRONTIUM AND CALCIUM.

By M. D. SIDERSKY.

THE method of separating these two metals is based on the following reaction:—When a mixture of oxalate and sulphate of ammonium is added to a salt of strontium containing calcium, the precipitate contains all the strontium in the form of sulphate, whilst the whole of the calcium is found in the form of oxalate. These two salts are then easily separated by dilute hydrochloric acid. By previously adding a little hydrochloric acid to the solution the precipitation of oxalate of calcium is prevented.

The method of working is as follows:—Suppose a strontianite is to be analysed. The powdered mineral is attacked at the boiling-point by the smallest possible quantity of strong hydrochloric acid, and the solution

supersaturated with ammonia, which precipitates iron, alumina, and silica. After filtration the liquid is concentrated by evaporation, acidulated with hydrochloric acid, and precipitated by a solution containing, per litre, 200 grms. of sulphate and 30 grms. of oxalate of ammonium. This precipitates sulphate of strontium, which is collected on a filter and weighed after washing. The filtrate, supersaturated with ammonia, yields a precipitate of oxalate of calcium.

The analytical results which the author quotes in support of this method are satisfactory.—*Zeitschrift für Analytische Chemie.*

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month ending November 30th, 1883.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P., Professor of Chemistry at the University of Oxford.

and C. MEYMOTT TIDY, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the Water Examiner, Metropolis Water Act, 1871.

London, December 6th, 1883.

Sir,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the seven London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from November 1st to November 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and the Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples submitted to analysis.

Of these 182 samples of water, the whole, with the exception of three samples which were recorded as "very slightly turbid," were clear, bright, and well filtered.

The supply throughout the month has continued to be of excellent quality; and in particular, the proportions of organic carbon, and consequently of organic matter, though in excess of the very small amounts recorded for several months past, have been low for the season of the year.

It will be observed that despite important differences of interpretation, the actual results obtained by ourselves are usually in fair accordance with those reported to the Registrar-General. Thus the mean amount of organic carbon in 100,000 parts of the water furnished during the six months preceding October, by the five Companies taking their supply exclusively from the Thames was, according to our experiments, 0·116 part, and according to the reports made by the Registrar-General, 0·123 part, a difference of 0·007 part only. As regards, however, the discrepancy noticeable in the two sets of results for October, we would call attention to the circumstance that our report was based on an examination of nineteen specimens of Thames-derived water, each collected on a different day; and that our determinations of organic matter by means of the combustion process were checked by the results of a wholly different process of examination. On the other hand, the report made to the Registrar-General on the character of the Thames "waters supplied to the Metropolis *during* the month of October," was based on an examination of five specimens only, all collected on the same one day of the month. Further, the results, furnished by the combustion process applied to these five specimens, were wholly unchecked by any different method of examination.

We are, Sir,
Your obedient Servants,
William Crookes,
William Odling,
C. Meymott Tidy.

ON CADMIUM IODIDE.

By F. W. CLARKE and E. A. KEBLER.

Of late years the suggestion has repeatedly been made, by various chemists, that the definite series of related chemical elements may be analogous in character to series of compounds such as the hydrocarbons. For example, fluorine, chlorine, bromine, and iodine form one such series; the nitrogen group, from nitrogen to bismuth, forms another, &c. There have been many efforts to trace relationships between the atomic weights in these and other similar series, and so to get evidence in favour of the foregoing hypothesis; but except in the establishment of the periodic law, all such attempts seem to have ended fruitlessly.

But notwithstanding the failure to discover definite numerical relations between the elements, the evolutionary speculation is suggestive. If the series of elements are developed progressively, like series of compounds, there should be various points of comparison; and one line of thought is as follows. In any series of compounds the possibility of isomerism increases as we ascend; and therefore, by analogy, we should expect to find a similar state of affairs among the so-called elements. The derivatives of the highest member of a series should be more numerous and complex than those of lower members, and cases of allotropy or isomerism ought also to be more frequent. Whether this is so or not in all known instances we do not attempt to say; our experiments bear upon a single point, and that may be stated briefly.

It is a well-known fact that allotropy is common among the metallic iodides, and much more so than among the corresponding compounds of chlorine and bromine. For example, the scarlet and yellow modifications of mercuric iodide, and the three varieties of antimony iodide may be cited. We have been engaged in the study of several other iodides, especially that of cadmium, and in this case we are now prepared to announce the existence of two distinct modifications. So far, then, our results lend countenance to the speculative idea which we began by quoting, even though much weightier evidence would be needed to put it upon the basis of a clear and definite theory. The speculation, however, instigated our experiments, and in their success its utility as a means of stimulating research is justified.

Up to the present time but two determinations of the specific gravity of cadmium iodide have been published. First, by Bödeker, who found it to be 4·576 at 10°; and, second, by Fullerton, whose mean result was 5·9798. The latter determination was made some years ago in this laboratory, and is undoubtedly too high; but the discordance between the two is so great that it could hardly be ascribed to error. Accordingly, we prepared cadmium iodide by a variety of methods, and obtained the following determinations of specific gravity. All weighings were made in benzene, and the results are referred to water at 4° as unity. Our mean figures may be stated first, and the details given later.

A. Cadmium and iodine, in equivalent quantities, were heated together in a sealed tube from which the air had been exhausted. The product was white, and contained

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LONDON:

PRINTED BY EDWIN JOHN DAVEY,

BOY COURT, LUDGATE HILL, E.C.

3 2044 048 675 300